THE DESIGN OF HEALTHCARE FACILITIES: KNOWLEDGE, METHODS AND EFFECTIVENESS

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ABSTRACT

Apparent deficiencies in the design quality of healthcare buildings raise an important issue for designers and users. It has been reported that designers have failed in fulfilling the clients' expectations and requirements, which has resulted in a *'design performance gap'*. This research focuses on the design of hospital premises and the associated performance gap. The purpose of this study was to compare the way designers perform with the satisfaction levels of healthcare users and having done so, to produce a better understanding of how this might be improved.

The first stage was a literature review of existing work on the assessment of design performance, performance gaps and ways of closing them, with particular focus on the key issues in the design of healthcare facilities. Two data collection methods were adopted: two surveys that encompassed Likert scale and open-ended questions, and a set of in-depth interviews. The first survey was assigned to designers to explore their awareness and response to important problems encountered in the design of healthcare facilities. This was followed up by in-depth interviews with selected designers. The second survey questioned the satisfaction of healthcare users about aspects of the design of their healthcare environment. Hypothetically, a variety of outcomes was possible based on the designers' awareness (or lack of) of key issues in healthcare facility design, their response (or lack of) to these, and the satisfaction or dissatisfaction of healthcare users. In fact, two situations emerged (1) that in some respects designers are aware of the issues, think they are addressing them, and users are satisfied; (2) in other respects, however, although designers are still aware of the issues and believe they are addressing them, users are nevertheless dissatisfied.

The conclusion is that designers have insufficient information on certain user requirements. Better user information is paramount for better design decision-making and for the quality of healthcare facility design. A conceptual framework and matrices were developed that could raise awareness of this and help in improving design decision-making through improved Post-Occupancy Evaluation and ultimately, with digital technology, be captured in a knowledge base. This framework and associated matrices have been developed at a relatively high level, and further work would be required to operationalize them for use in actual healthcare projects.

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GLOSSARY OF TERMS

ADB	Activity Database Activity Database (ADB) is a computerised package to assist healthcare planners, architects, and teams involved in the briefing, design and equipping of healthcare environments. the essential tool in your BIM tool-kit."
BIM	Building Information Modelling is a process supported by various tools, technologies and contracts involving the generation and management of digital representations of physical and functional characteristics of places.
BMS	Building Management Systems (BMS), also known as a building automation system (BAS), is a computer-based control system installed in buildings that controls and monitors the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems, and security systems.
BN	Building Notes or Health building notes give best practice guidance on the design and planning of new healthcare buildings and on the adaptation or extension of existing facilities. They provide information to support the briefing and design processes for individual projects in the NHS building programme.
COBie	Construction Operation Building Information Exchange is a non-proprietary data format for the publication of a subset of building information models (BIM) focused on delivering asset data as distinct from geometric information.
EBD	Evidence-based design is the process of basing decisions about the built environment on credible research to achieve the best possible outcomes.

HTMs	Health Technical Memoranda give comprehensive advice and guidance on the design, installation and operation of specialised building and engineering technology used in the delivery of healthcare.
IRAS	Integrated Research Application System is a single system for applying for the permissions and approvals for health, social and community care research in the UK.
KM	Knowledge Management is the process of creating, sharing, using and managing the knowledge and information of an organization.
LEED	Leadership in Energy and Environmental Design is the most widely used green building rating system in the world. Available for virtually all building project types, from new construction to interior fit-outs and operation & maintenance, LEED provides a framework that project teams can apply to create healthy, highly efficient, and cost-saving green buildings. LEED certification is a globally recognized symbol of sustainability achievement.
P22	ProCure22 is a Construction Procurement Framework administrated by the Department of Health & Social Care for the development and delivery of NHS and Social Care capital schemes in England.
POE	Post Occupancy Evaluation is the process of obtaining feedback on a building's performance in use.

LIST OF ABBREVIATIONS

ADB	Activity Database
AEC	Architecture, Engineering, and Construction
BIM	Building Information Modelling
BMS	Building Management Systems
BS8300	British Standards8300
BN	Building Notes
CAD	Computer-Aided Design
CARDIAC	Cardiology
CCU	Coronary Care Unit
CMS	Content management system
COBie	Construction Operation Building Information Exchange
CPD	Continual professional development
D&B	Design and Build
DBFO	Design-Build-Finance-Operate
DIMH	Design in Mental Health
DoH	Department of Health
EBD	Evidence-based design
FF&E	Fitting Furniture and Equipment
FGI	The Facility Guidelines Institute
FM	Facility Managers
FSTC	Field studies of thermal comfort
GDP	Gross Domestic Product
GMP	Guarantee Maximum Price
HBNs	Health Building Notes
HC	Healthcare
HCBs	Healthcare Buildings
HCFs	Healthcare facilities
HCPs	Healthcare Projects
HDU	High Dependency Unit
HIS	Healthcare Infection Society
HTMs	Health Technical Memoranda

HVAC	Heating Ventilation, Air Conditioning
ICU	Intensive Care Unit
IRAS	Integrated Research Application System
KM	Knowledge Management
LEED	Leadership in Energy and Environmental Design
M&E	Mechanical, Electrical
MECH	Mechanical
MEP	Mechanical, Electrical and plumbing
NEURO	Neurology
NHS	National Health Service
NHSI	National Health Service Improvement
ORTHO	Orthopaedics
P22	ProCure22
PFI	Private-Finance Initiative
POE	Post Occupancy Evaluation
PPP	Public-Private Partnerships
SPSS	Statistical Package for Social Sciences
VENT	Ventilation

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DEDICATION

This thesis is dedicated to my beloved parents who raised me to the person I am today. Thank you for showing me affection along with support and guidance. Thank you for your endless efforts and every single advice you gave me and still support me throughout my life.

DECLARATION

I declare that the work contained in this thesis has not been submitted for any other award and it is all my own work. I also confirm that this work fully acknowledges opinions, ideas and contributions from the work of others.

Any ethical clearance of the research presented in this thesis has been approved. Approval has been sought and granted by the University Ethics Committee on [11/05/2018] and NHS Ethics on [08/06/2018].

I declare that the Word Count of this Thesis is 85,657 words

Name: Touria Bouazza

Signature:

Date: 12/12/2019

CHAPTER ONE

1 INTRODUCTION

1.0 BACKGROUND TO THE RESEARCH

The apparent inability of buildings (either because of their design, or because of the way they were constructed) to meet the needs of their users has been noted by numerous critics highlighted by industry-level reports (Latham 1994, Egan 1998, Wolstenholme et al. 2009). There is also criticism of the products that result from the construction process. As well as the more obvious of these, such as defects (Josephson and Hammarlund 1999, Forcada et al. 2016, Kraus et al. 2017), there are performance miscalculations and misconceived designs that are simply not fit for purpose (Somboonwit and Sahachaisaeree 2012, Driza and Park 2013, Smith 2016, Van den Brom et al. 2018). This is made worse by the disconnect between designers and users in terms of meaningful feedback (Kujala 2003, Steen et al. 2007, Jensen 2011, Andrade et al. 2012, Caixeta et al. 2013).

The criticisms of the industry that are highlighted in the above reports relate to all construction sectors and all phases of the process, from initial design to final use. However, in this study the focus is on the design of healthcare facilities. Like all buildings, healthcare facilities should be well designed, be constructed with no defects and provide a healthy and suitable environment for their users. In the case of healthcare buildings (HCBs), these users include patients, medical staff, administration professionals, etc. HCBs are particularly complex because of the multi activities involved in their design and construction, as well as the activities of users at the occupancy stage. Architects and other designers have an important role in designing the HCBs, in order to ensure that what they design is adequate for care delivery (Caixeta and Fabricio 2013). Healthcare buildings may include general hospitals, specialised hospitals, teaching and clinics, in addition to other facilities. People who get healthcare may be inpatients (patients who stay in the hospital over a period) or outpatients (patients who have a consultation with a Medical staff then leave the facility). Their needs and those of other users such as clinicians, nurses, and ancillary staff may be affected negatively if the building is not well designed. On the other hand, these buildings may face some challenges; issues such as environmental comfort, sound insulation, and other aspects of space design issues (Bartley et al. 2010). To be able to face the challenge,

architects need to know about the problems faced by the users and those responsible for them. This is, in theory, achieved by post-occupancy evaluation (POE), which helps the design team produce better designs (Nemeth and Cook 2007) by 'feed-back' to designers, thus creating knowledge for improved designs and avoiding the repetition of previous mistakes (De Jager 2007).

1.1 PROBLEM STATEMENT

The failure to meet the expectations and requirements of the whole life cycle of the building, which have been highlighted by the aforementioned reports, involves owners, users and those responsible for the running and upkeep of the building, such as facilities or asset managers. For simplicity, this group is referred-to here as 'user-stakeholders'. The proposed research leaves aside the aspect of defective construction (albeit an important issue) and focuses on the suitability of building design. To address the problem of not meeting the expectations, according to Preiser (1995), Preiser et al. (2015) and Hadjri and Crozier (2009), it is well established that feedback from post-occupancy evaluations (POE) can offer significant benefits to design decision-making. If designers are able to take advantage of the post-occupancy evaluation (POE) and get access to the feedback from the users of facilities, the requirements of user-stakeholders will be more likely to be achieved through improved design decision-making (Foulds et al. 2013, Johnston et al. 2016, Hay et al. 2018). However, whilst useful feedback is undoubtedly assimilated tacitly by designers (more details in 'Pattern Language' section, Chapter 2), it is clear that constructive feedback is most useful when it is explicitly incorporated into designers working' practices (Hey 2004, Kanapeckiene et al. 2010). One possibility for transforming such tacit knowledge into a more reliable explicit version using a knowledge base underpinned by new technologies such as Building Information Modelling (BIM). This is simply shown in Figure 1 below.

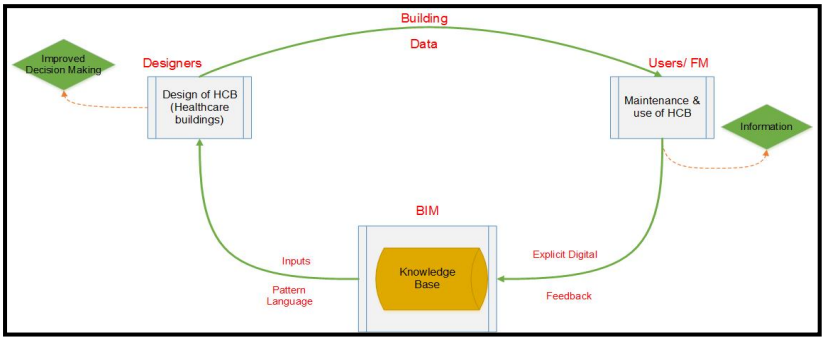

Figure 1.1: POE feedback (Research Concept high level).

It has been noted that there are obstacles to the effective working of this feedback system, these include:

1. Design culture. The term 'pattern language' was introduced by architect Christopher Alexander to describe a classic approach to design problems. Such patterns are valuable, but external feedback may be seen as disruptive (Alexander et al. 1977);
2. Lack of understanding by designers of what feedback could be available (Andreu and Oreszczyn 2004);
3. Lack of understanding by user-stakeholders of what feedback could be valuable (Gupta and Chandiwala 2010);
4. Laborious process of feedback capture, subsequent store, retrieval and use (Zammit et al. 2018);
5. The limitations of systematic Knowledge Management: various organisations have attempted to adopt systematic KM but alas, there have been no concrete achievements so far (Newell et al. 2006, Dave and Koskela 2009).

According to the latest report of the National Building Specification (NBS 2019), design information is increasingly being produced in digital format, which makes of BIM an important standard of the industry to develop, deliver and maintain construction projects. When the digital model of the completed building is transferred to the maintenance and use of the building, information is then generated during the whole lifecycle of the building. This information is also increasingly available in a digital format, and could potentially be fed back to designers. The designers would access this information and use it in other projects in order to improve the decision-making and the quality of the building. Thus, the feedback given from the users would increase the supply of a knowledge base to designers of the buildings where they could refer to it at the start of any other project (Cooper 2001) as shown in the figure above. The main problem to tackle in this research is the deficiencies of building design quality due to the lack of user-feedback.

1.2 AIM AND OBJECTIVES

The research aim is to develop a conceptual framework for the design of healthcare facilities based on users' needs.

The concept is informed by the post-occupancy assessment of experienced users and builds upon the current awareness of healthcare facilities designers. It is not the intention to implement an actual knowledge management system as part of this research: but the

conceptual framework presented (Figure1.1) would provide a basis for its live implementation in the future and could also incorporate emerging technologies, such as Building Information Modelling (BIM).

In order to achieve this aim, the following objectives were adopted:

1. Investigate the design issues and problem areas associated with the design of healthcare facilities.
2. From a sample of specialist healthcare design practices, determine:
    a. designers' awareness of the identified design issues and problem areas;
    b. the sources of knowledge that designers access (e.g. tacit or explicit)
    c. whether they use a systematic knowledge repository and/or digital technologies;
    d. the potential for operational feedback to inform better designs.
3. From a sample of experienced healthcare users, determine their satisfaction with the design of healthcare facilities.
4. From a comparison of the findings (2 and 3, above) identify key areas where there is a lack of alignment between designers' awareness and users' expectations.
5. From these key areas what could be addressed and what steps would inform better designs.
6. Create a conceptual framework that enables the better capture and use of post-occupancy evaluation in healthcare facility design.
7. Explore the theoretical and practical implications of the findings and the framework, and their contribution to knowledge.
8. Make recommendations for further work including the implementation of the conceptual framework.

1.3 RESEARCH QUESTIONS

1. What are the key design issues in hospital wards?
2. Are the designers of hospital wards producing suitable designs?
    2.1. Are designers aware of the key design issues and are they addressing them?
    2.2. What information is most useful to designers and is it available to them?
    2.3. What further information could produce better design and improve design decision making? and could it be transferred to them automatically?
3. Are the healthcare users satisfied with the design of hospital wards?

1.4 METHODOLOGICAL STEPS

To achieve the objectives of the research, the following strategies and methods will be adopted:

Stage one: Literature review

- Literature review on the design issues of health care facilities (addresses Objective 1).
- Literature review of the post-occupancy 'performance gap' between buildings as they are designed and buildings-in-use, Knowledge Management (KM) and digital technologies such as Building Information Modelling (BIM) (addresses Objective 2 b and c).

Stage two: Data collection

- To select the architectural healthcare practices for the research based on location (addresses Objective 2).
- Establish a questionnaire with list of issues faced during the design that are covered in the literature review then send it to the design team (addresses Objective 2 a and b).
- Use one-to-one interviews with designers to (i) investigate the tacit knowledge implementation in the design, (ii) assess the implementation of digital platforms such as BIM and (iii) come up with the specific data that designers would find useful to improve the design quality of the projects, which are the outputs of the questionnaire (addresses Objective 2 b, c, and d).
- Establish a questionnaire with healthcare users to investigate their satisfaction (addresses Objective 3).

Stage three: Data analysis and development of a conceptual framework for knowledge-management

- Compare the findings from both samples to establish the areas of alignment and nonalignment (addresses Objective 4).
- Analyse the data provided from user-stakeholders and designers to establish feedback and requirements' matrices (addresses Objective 5).
- Create a conceptual framework that improves understanding and demonstrates the flow of post-occupancy data back to building designers in order to improve their future design decisions (addresses Objective 6).

Stage four: Validation of the conceptual framework

- Submit the conceptual framework to the scrutiny of experts in the field to achieve its validation from theoretical and practical perspectives (Objective 7)

- Summarise the contribution to knowledge and make recommendations for further work (addresses Objective 8).

1.5 RESEARCH SCOPE

The research focuses on the design of healthcare facilities in the UK, specifically on the design of hospital inpatient wards. The research uses responses from healthcare designers and healthcare users (which includes staff and healthcare allied professionals). Although they may be relevant, it does not include the views of patients. This is further considered in the 'limitations' section of Chapter 7.

1.6 STRUCTURE OF THESIS

The thesis is organised into seven (7) chapters. It inaugurates the research story with an introductory chapter (Chapter 1), followed by a literature review (Chapter 2) that discusses the design problems along with the performance gaps. This will be followed by a research methodology chapter (Chapter 3), which outlines the methodology followed and the methods implemented. The following chapters (Chapters 4 and 5) will present and analyse the data collected and their results followed, in Chapter 6, by discussion of the findings and the development of a conceptual framework. Finally, the thesis concludes with Chapter 7 (Conclusion), which describes the limitations and challenges of the work alongside its contribution to knowledge and recommendations for further research. The content of each chapter is briefly described as follows:

Chapter 1: Introduction.

This chapter introduces the reader to the issues the research seeks to address, the aim and objectives of the research, as it demonstrates the overall process of the research.

Chapter 2: Literature review.

This chapter provides the reader with an overview of literature related to the issues of design in healthcare facilities and the approaches to tackle them with Post-Occupancy evaluation (POE), followed by a section on pattern language based on which designers get information in from POE. This chapter will also discuss the importance of managing knowledge in undertaking healthcare projects.

Chapter 3: Research methodology.

This chapter will outline the methodology used in this research to meet the aim and objectives of the research. It will include descriptions of the research design as well as the research methods used and the methods of data collection.

Chapter 4: Analysis of data collection and results (1).

This chapter is devoted to the first part of data collected during the research and their analysis.

Chapter 5: Analysis of data collection and results (2).

This chapter is devoted to the second part of data collected during the research and their analysis.

Chapter 6: A conceptual framework.

The purpose of this chapter, based upon a discussion of the findings, is to produce a conceptual framework and to validate it by scrutiny by experts in the field

Chapter 7: Conclusion.

Finally, the research story is concluded with recommendations for further research and practice. The chapter outlines as well the limitations and challenges met during the research journey. The figure below illustrates the thesis 'organisation into seven chapters.

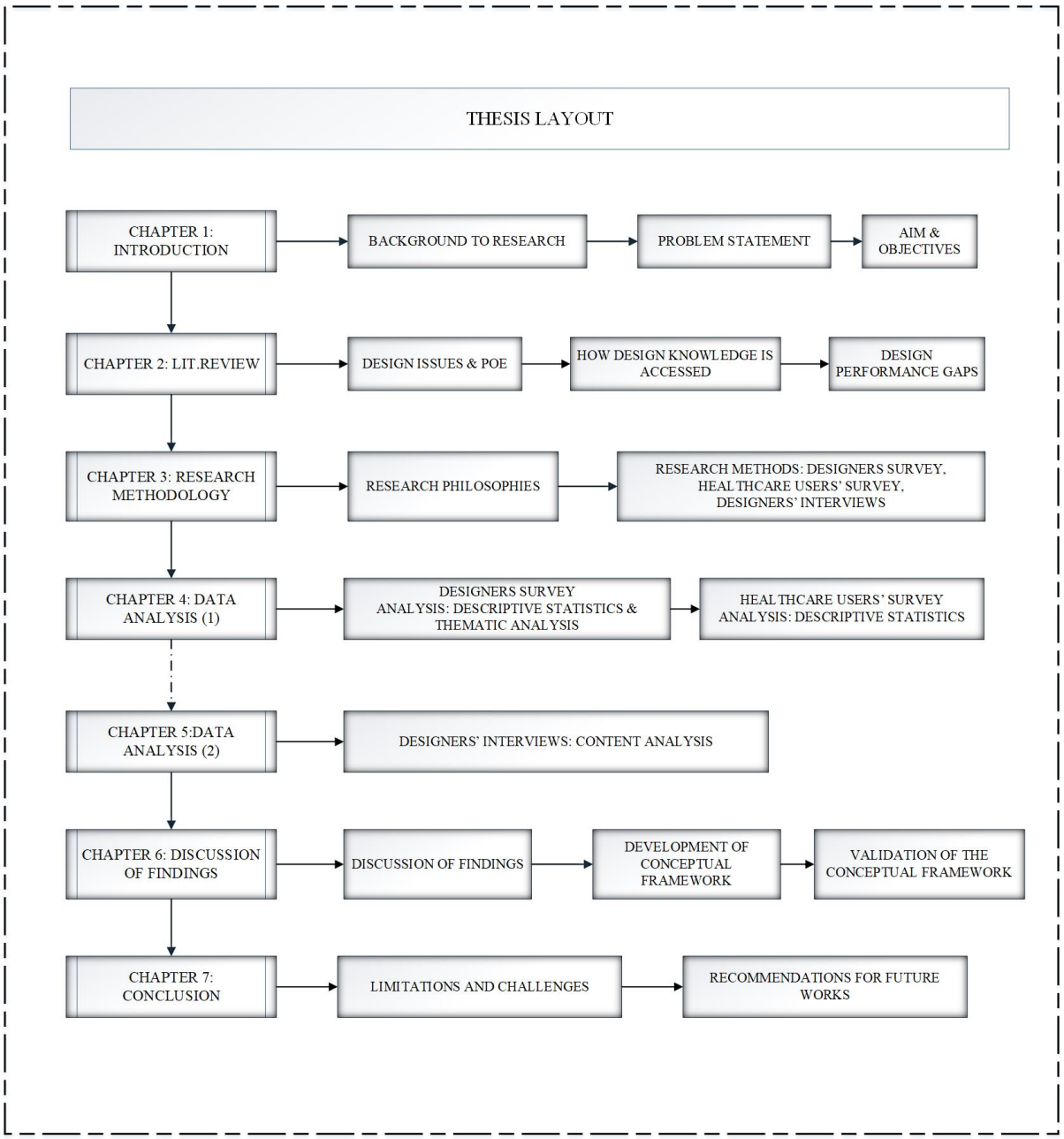

Figure 1.2: PhD research thesis structure.

CHAPTER TWO

2 HEALTHCARE FACILITY DESIGN: A REVIEW OF RELATED LITERATURE

2.0 INTRODUCTION

This chapter first outlines an overview of the design of healthcare facilities and their procurement. Then it discusses the issues in the design of healthcare facilities, which are followed by a discussion of the healthcare users' perceptions of the design. This chapter also discusses the importance of knowledge, evidence-based design, pattern language and post occupancy evaluation 'POE' in the design of healthcare premises as well as the use of the emerging technologies such as Building Information Modelling 'BIM'. It also discusses the reasons for which designers do not meet the client's requirements in the design and the way it could be improved. Finally, the chapter concludes with a summary of the main heading and introduces the insights to the next chapter.

2.1 THE DESIGN OF HEALTHCARE FACILITIES

The construction industry has a significant role in its contribution to the UK economy, which is up to 10% of gross domestic product (GDP) (Pearce 2003). Its activities are primarily concerned with the planning, regulation, design, manufacture, construction and maintenance of buildings and other structures (Harvey and Ashworth 1997). Furthermore, the construction industry is beneficial in generating employment for more than 2.8 million people and the globalization of construction works around the world (House of Commons Business and Committee 2008). The construction industry is huge and encapsulates the sector of building, civil engineering and the process-plant industry (Harvey and Ashworth 1997). Construction works vary in terms of size and type of projects undertaken and the number of professionals required (Harvey and Ashworth 1997, Morton and Ross 2008). The construction industry is also flexible in terms of responding to a huge and varied demand (Morton and Ross 2008). Harvey and Ashworth (1997) have cited the characteristics that distinguish it from other industries:

1. The physical nature of the product.
2. The product is normally manufactured on the client's premises, i.e. the construction site.
3. Construction projects are one-off prototype.
4. The arrangement of the industry, where design has normally been separate from construction.
5. The organisation of the construction process.
6. The methods used for price determination.

According to several definitions, the construction industry's principal goal is to deliver and maintain the built environment which encompasses housing, educational, healthcare, commercial, industrial, and infrastructure facilities that cover communication, the provision of electricity, water, sewerage, air, gas, railway, harbours, dams, bridges, roads and so on (ONS 2002, Frenz and Oughton 2005, Ankrah 2007).

The healthcare sector is concerned with the design of healthcare facilities 'HCFs' that encompass a variety of types from small to large premises including medical clinics, teaching and research hospitals (Carr 2017). Fiset (2005) described the healthcare facility as a term combining both 'hospitable' and 'hospital' where both need to be used together. He defined hospital as "a small city, with its own internal network of avenues, streets and back alleys; services are organised along and between these arteries as in neighbourhoods". Healthcare infrastructures could also include primary care trust, and provide several activities to patients, visitors and staff (Ibrahim and Price 2005). Hospitals are considered to be complex buildings, their design is a dynamic process that includes many stakeholders coming from different cultural knowledge and interests (Chandra and Loosemore 2011, Van Hoof et al. 2015).

The construction of a hospital project goes through three phases that are the briefing, the design and the construction phase. Villeneuve et al. (2007) compared the design process of a hospital to a 'LEGO' session where all blocks are assembled to form the final shape going through a study of ergonomics of the multiple rooms in the different care units. During the brief of HCFs, all stakeholders need to meet and discuss the client 'needs and optimal requirements; however, one of the causes of not meeting the client' expectation could be the misunderstanding of users' needs, hence these exchange of feedback and information during the brief could be misinterpreted or poorly communicated (Chandra and Loosemore 2011).

Any construction project requires procurement of different resources; however, it exists different ways of procurement, which are distinguished from one another. Multitude of different forms of contracts has been highlighted in the Egan (1998) and Latham (1994) reports, as described in (Morton and Ross 2008) there are three or four main methods of procurements, each with some variations. The set of ordering and managing a construction project used to be called 'procurement routes' that are divided into traditional and non-traditional procurements. As highlighted in (Harvey and Ashworth 1997) the differences between the procurement methods could be; either in the way of selecting people to undertake the tasks, or the succession of stages from design to construction on site, or the nature of relationships between contractors, consultants and clients. The traditional method of procurement was developed at the beginning of the twentieth century and follows a number of stages starting from determining the type of building and requirements needed by the client to the use of the project, whereas, the non-traditional method is called design and build (Harvey and Ashworth 1997). According to the Royal Institute of British Architects (RIBA 2013), there are five common procurement routes that exist and are used in the industry.

According to a survey that has been conducted by RIBA members online, the most used one is the traditional procurement with 86% followed by one-stage: design and build with 41%, then two-stage: design and build with 39%, the least used ones are management contract with 18% and the private finance initiative (PFI) with 10%. However, Healthcare facilities 'HCFs' are generally procured by Private Finance Initiative 'PFI' that represent 20.31% of the public projects and this represents 10.48% of the total capital value of the UK PFI projects (Akintoye and Chinyio 2005). PFI is part of the Public Private Partnership 'PPP' and follows the model (DBFO) which is design, build, finance and operate in the delivery of healthcare projects 'HCPs' in the United Kingdom (McKee et al. 2006) that has some risks namely, cost, flexibility, quality and complexity of the project. Another initiative to procure healthcare buildings 'HCBs' is ProCure21, which is a programme that helps in enhancing the performance of public sector clients in capital procurement, its specificity is to prolong the relationship between the NHS and the construction industry (Akintoye and Chinyio 2005). The National Health Service (NHS) is the responsible for the delivery of healthcare in the UK under the direction of the Department of Health (DoH). HCFs could also be procured with ProCure21, which is a type of procurement method used for publicly funded NHS schemes that do not involve PPP/PFI (Thomson Reuters 2009).

The NHS ProCure21 is a framework that relies on best practice in the private sector and provides more value to the NHS in several ways such as (i.e. long-term relationship with principal supply chain partners, enable the integrated design and construct services, planning for construction starts in detail design, etc.). Furthermore, ProCure21 is a process that enables all stakeholders in working as a team together from the beginning to the end, and it delivers the project within a guaranteed maximum price and a delivery date (Brighton & Sussex University 2016). ProCure21+ has more options than the previous procurement that includes the use of new platforms such as BIM, the enhancement of cost issues and better efficiency and value (NHS 2015). As opposed to PFI and PPP that used to fund healthcare projects privately, ProCure 21+ and ProCure 22 (P22) is used to fund HCPs publicly and is used for (i.e. service planning, refurbishments, minor works, infrastructures upgrades and feasibility studies), however it does not provide the fund (NHS 2015). ProCure 21+ has been replaced recently by ProCure 22 (P22) that involves Pre- and Post-occupancy evaluation toolkit to provide better healthcare buildings (NHS 2016).

A hospital is divided into five distinct areas that are inpatient, outpatient, diagnostic and treatment, support and administration (MAPS 2018). This research focuses upon the design of inpatient wards and their issues. The inpatient ward changed increasingly over 50 years from multi large bed-bays to private rooms in order to provide more privacy to patients (visual and audio) (MAPS 2018). Francis et al. (1999) discussed the most famous type of ward that was designed in the UK in the past, which is the Nightingale ward. Florence Nightingale came up with the idea of designing a long straight corridor space with beds on either side, a high ceiling and parallel windows on both sides (Francis et al. 1999, Hughes 2000). However, this layout allowed little accessibility to lights, unlike the Rigshospital ward layout that allowed more lighting (Hughes 2000). Hughes (2000) discussed the evolution process of wards' design that went through many changes from the Nightingale plan to private rooms. Yet, as any typical design, the design of wards still encounters problems during the design.

2.2 ISSUES IN THE DESIGN OF HEALTHCARE FACILITIES

Joseph and Rashid (2007) argued that failure to follow the design principles could impact adversely on the design, hence the patient safety. A wide range of research works discussed the appearance of such design problems and issues of HCFs; these common problems were established based upon the design principles that were issued in the design guidance 'health

building notes' (HBNs). Phiri (2014) discussed a set of design principles that should be considered in the brief of the design, these are namely daylight, air quality, acoustic and noise, thermal comfort, artificial lighting, fall prevention and others. In addition, other design principles were seen important and at the same time considered as issues noticed after occupancy such as noise, infection control, scalability, adaptability, flexibility of the space, medication errors, isolation of rooms and beds, privacy and dignity and colour used in space (Reiling 2006, Clancy 2008, Phiri 2014). HCFs are complex buildings that not only involve the design aspect but mechanical and electrical complicated systems (Fiset 2005). In other words, hospitals demand high rates of air changes to control infection, which is one of the notable issues that need to be addressed by designers. Infection control was related to the design of wards since the 1930s, where designers started to design smaller bed bays to increase patients' privacy and mitigate the infection aspects (Hughes 2000).

Hughes (2000) stated that the design of hospitals has tremendously changed in terms of size and complexity, and this was mainly perceived by inpatients who noticed change in the design of wards that was meant to be adaptable to medical and social developments. Regarding the design of wards, a simple configuration of layout that included open ward with 30 beds was a default design of Nightingale, who designed the ward based upon medical orientations (limitation of infection through high-ceilinged wards cross-ventilated by windows) and social orientations (interactions between patients in same ward) (Hughes 2000). However, this design showed a lack of privacy and noisiness aspects, alongside the social culture (same gender ward-allocation). Flexibility and adaptability of the space is another issue in the design of hospitals, these two terms have been defined by Fiset (2005) who explained that hospital design needs to suit the different medical practices as well as the emerging technologies and new developments. For this, the design must comprehend two factors: adaptability that he defines as "refers to versatility, to the possibility of using the same space for multiple functions" and the flexibility defined as "the ability to change internally and to grow externally, and to replace parts that have become obsolete". Designers need to follow a set of guidance and references to design HCFs, and this to ensure the optimal delivery of projects and their ability to meet the users' requirements.

2.3 DESIGN GUIDANCE FOR HEALTHCARE FACILITIES

The Department of Health (DoH) developed an ergonomic database to follow in the design of HCFs that was improved later as Health Building Notes (HBNs) (Hignett and Lu 2009). HBNs were first published in 1961 that were divided into three sets of documents enabling designers to fulfil the requirements of design (Francis et al. 1999). According to Phiri (2014), designers use HBNs to base their designs upon best practices for either the planning of a new built or a refurbishment of an existing built. HBNs is subdivided into 17 core subjects and each has a set of practice guidance in it (Phiri 2014). Furthermore, Health Technical Memoranda (HTMs) and Activity Database ADB were perceived to be used along with HBNs during the brief of HCFs in terms of medical gases or additional guidance. In addition to the practice guidance, designers use their expertise and knowledge to address the gaps within the design regulations; this could be compensated with evidence-based design (EBD), pattern language or post-occupancy evaluation (POE).

2.3.1 EVIDENCE-BASED DESIGN, KNOWLEDGE, PATTERN LANGUAGE AND POST-OCCUPANCY EVALUATION

In terms of Evidence-Based design (EBD) many research works have proved the benefits of users' perceptions from the design of HCFs, in formats such as Evidence Based Design 'EBD' (Andrade et al. 2012). EBD was defined by Andrade et al. (2012) as a term to base design upon the best research findings and added that EBD does not only rely on designers' requirements and knowledge but necessitates the opinions of users to be able to create a space fit for purpose and meets the requirements needed by users. Rashid (2013) defined EBD as a process-involving design-decisions based upon best practices and research on the built environment. He also stated that the design of HCFs witnessed many benefits from the implementation of EBD approach, such as increasing the satisfaction level of HC users, decrease the infection rates, reduce noise and medication errors and enhance the workflow in the buildings. Ulrich et al. (2008) argued that EBD has many positive outcomes on the safety of patients and the working conditions of staff, and added that EBD should be a continuous process despite the shortage of evidence because of the several improvements EBD brings to the built environment hence the healthcare building and resulting in better healthcare delivery. However, the implementation of evidence-based design is limited due to the lack of mechanisms of being in possession of knowledge that is related to the design of HCFs (Rashid 2013).

Llewellyn (1957) referred to knowledge as a raw material for design, and that is necessary to produce great imagination and creativity skills in design. As to an architect who should be in possession of a higher level of knowledge in design to be able to reach any achievements in meeting the user's requirements design related. Hay et al. (2018) found out that construction stakeholders would find it beneficial to capture learning and knowledge of past projects, in order to avoid repetitive mistakes on other projects, and mentioned that one of the participants in their research said that "there is such a leakage of knowledge, it is painful". Bellinger et al. (2004) have identified the difference between the categories of human mind that are; data, information, knowledge and wisdom. Ackoff (1989) defined data as symbols, which are converted into information by being processed to answer usefully to "who", "when", "what" and "where" questions; once data and information are applied, question "how" are answered automatically which make it level of knowledge, when the user appreciates "why" questions he processes to the understanding of all the categories. Finally, the evaluation of the understanding leads to a new level that is called wisdom. According to Ackoff (1989) data is raw, it has no significance in itself if no applied in any domain, and could be usable as it could be unusable. Bellinger et al. (2004) encapsulated all the categories of the human mind cited in in the diagram below (Figure 2.1); where data does not have any relation to other things, indeed it explains or describes a fact or an event happening or happened in the past for instance: it is raining. Whereas, the information embodies the understating of relations between causes and effects for instance: the temperature dropped to 13 degrees, as a result it rained. Knowledge understands the pattern of something known in your mind such as a refrigerator, a box, a computer, etc. The last step of understating embodies the principles at wisdom level, at which the user needs to understand all the previous categories to reach such a level of understanding.

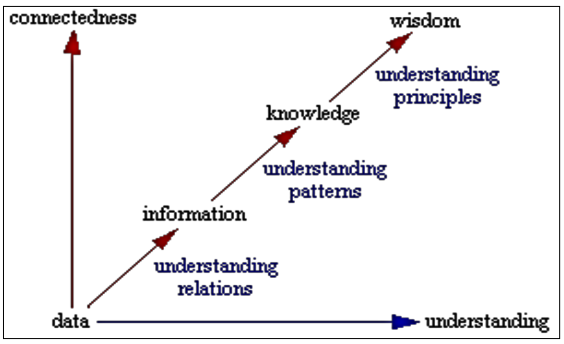

Figure 2.1: Transition from Data to Wisdom. (Diagram realised by Bellinger *et al.*, 2004).

Bellinger et al. (2004) defined knowledge as the accumulation and collection of information, once the individuals acquire the information, which will be stored and ultimately becomes knowledge that is used in subsequent situations. Knowledge that is residing in employee's minds is seen as the most important asset of competitiveness between the organisations in the building market; also knowledge has been defined as "know-how, know-why and know-who" (Kamara et al. 2002). Knowledge can be obtained by three ways either by being acquired from a person who has it or by instructions or by being derived from experience (Rowley 2007). Many authors have identified two types of knowledge that are tacit knowledge and explicit knowledge (Polanyi 1962, Nonaka and Takeuchi 1995, Hey 2004, Kanapeckiene et al. 2010). Tacit knowledge is difficult to decipher or communicate, as it is personal specifically to each context, tacit knowledge is hard to be recorded, formalised, or expressed clearly and it resides in individual minds (Nonaka and Takeuchi 1995, Hey 2004, Dave and Koskela 2009, Kanapeckiene et al. 2010). Whereas explicit knowledge is expressed clearly, it can be recorded and formalised, and could be accessible in documents such as procedure manuals, organisation maps, document management system, etc., (Kanapeckiene et al. 2010). In construction projects, explicit knowledge is collected and managed easily through documents that include storage and management of information and knowledge without having to retrieve explicit knowledge; yet tacit knowledge is considered according to industry professionals more important than explicit knowledge regarding its benefits in achieving competitive advantage besides of its complexity (Tupenaite et al. 2008, Kayaçetin and Tanyer 2009).

However, Sanchez (2005) argued that explicit knowledge 'advantages outweigh tacit knowledge' advantages, especially for organisations who want to leverage their knowledge and become a better learning, this will help them in achieving better competitive advantage, through the use of effective explicit knowledge approach. Moreover, Smith (2001) emphasised the fact that explicit knowledge is easily transformed into tacit in the presence of cooperation, trust and sharing. Patel et al. (2000) cited that construction knowledge could be both explicit and tacit knowledge that must be captured in order to provide benefits to organisations; hence, it requires some strategies to manage and capture this knowledge to help sharing it efficiently among the industry players. Gladstone (2000) mentioned the four ways in which knowledge could be converted or developed that have been classified by Nonaka and Takeuchi (1995) as illustrated in (Figure 2.2): Socialisation, Externalisation, Combination and Internalisation.

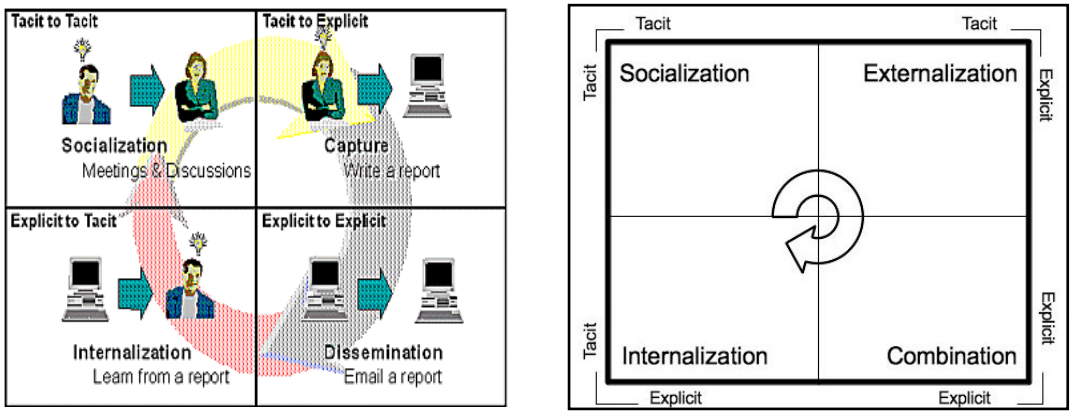

Figure 2.2: Knowledge Development/conversion (Nonaka and Takeuchi 1995)

According to the definition of Nonaka and Takeuchi (1995), socialisation is the first social process that transfers tacit knowledge between people. For instance, an intern who assists a qualified surgeon, or a trainee who watches a skilled worker to learn how the job is done, this knowledge changes in a continuous way in people's heads. The second process is the externalisation, which is about transfer of knowledge from tacit to explicit. For instance, tacit knowledge could be explicit by writing a report, filming an activity or recording a meeting, and when tacit knowledge is made explicit, it is identified as information. The third process is about combining two or more pieces of explicit knowledge, in order to create another explicit knowledge such as automated processes of sales reports and integration systems. Finally, the fourth process is about internalisation, where explicit knowledge is transferred into people's head to become tacit knowledge by valuing other's knowledge and re use it such as emails and reports.

Van Hoof et al. (2015) stated that the design of hospitals involves a multitude of experts with varied knowledge and information, which results in a complexity aspect of design process. These several experts and stakeholders work all together as a team to create a healing and comfortable environment for its different users, and for this, their expertise and information is a prerequisite. Therefore, design information is provided through direct feedback and transformation of tacit knowledge into explicit knowledge; however, this could be insufficient, and needs a fill-in gap with evidence-based design that can improve the design decision-making. According to Li and Zhang (2013), use of knowledge is paramount in the design of HCFs, and he justifies this statement with an example of infection from *airborne pathogens*, highlighting that designers necessitate to know about the process of Heating and ventilation.

He concedes that knowledge could be shared amongst people through IT use (Li and Zhang 2013). According to Alexander et al. (1977) '*Pattern language'* is an architectural language, which has been taken out from buildings. The main aim was to capture the design experience in civil engineering and architecture and to communicate the solutions to design problems with the clients. Indeed, this language is used for improving neighbourhood, designing a house, workshop or public buildings like schools, it is also used as a guidance for the construction process (Alexander et al. 1977). The elements that constitute the language are called patterns that describe building problems and solutions to be used. He defined '*Pattern language'* as "a pattern language is a system which allows its users to create an infinite variety of those three dimensional combinations of patterns which we call buildings, gardens, towns." In other terms, architects use a specific language to communicate their design as explained in Alexander et al. (1977); this language could be; square main room, about 3 meters, two step main entrance, small room off the main room, arch between rooms, main conical vault, small vaults within the cone, whitewashed top to the cone, front seat whitewashed and others. The pattern language could be found in other fields of study such as Medicine, where clinicians (Doctors) need to use specific terms in order to communicate with their fellows, and this helps in shaping and forming a special language between them or computer science using different languages as well.

Ellaway and Bates (2015) have used the theory of Christopher Alexander's work on pattern language to apply it in the medical field, stating that "the patterns of medical education are by definition perceived and shared by those involved in the field. Indeed, recognizing and using these patterns is arguably one of the defining aspects of the *doxa* of medical education. For a pattern to be shared it needs to be named, described, discussed and applied. In medical education much of this is generated from (but not necessarily by) scholarly acts such as papers, presentations and plans." In fact, the pattern language is not used only for buildings but also for streets and towns; as the term narrow streets and streets branching, which are used to shape streets and themselves in addition to other specific languages such as front door terraces, connected buildings, public wells at intersections, and steps in the streets help in shaping the town. These patterns are used constantly while constructing a building, street or town, by being repeatedly applied, they become tacit and a designer's luggage to use in the built environment. Also, Fincher (1999) identified four elements that characterise pattern language, including; capture of practice, abstraction, organising principle, value system, and presentation. Jörg and Frederik (2007) discussed the process of applying pattern language in

managing engineering knowledge, and this through different approaches. Primarily, they argued that pattern approach can be considered as a knowledge management approach, such as ontologies in the field of engineering design. They also referred to Nonaka and Takeuchi (1995), who argued that the pattern approach aims at combining knowledge, i.e. generating new knowledge through the automatic process of using the existing knowledge, however, they noted that the pattern language is a semi-formal approach with higher semantic power. Nonaka and Takeuchi (1995), consider the pattern language as a process that helps in knowledge internalisation, in addition to other approaches that help in knowledge internalisation such as Content Management System (CMS). Pattern language uses a multiple of information, which throughout the time, the user will absorb it tacitly and tends to use it at the event of a building design, or the occurrence of design problem, where the pattern will represent the solution. However, the beneficial use of information can be found in different forms, and the next section demonstrates it. Nonaka and Takeuchi (1995) accentuated the fact that the society is concerned with knowledge and gives it an important role that leads to innovation and improvement in large business organisations. They adopted a typical definition for both of knowledge and information by stating that knowledge is a true personal belief that is justified, whereas information is a flow of messages restructuring, adding to or changing knowledge.

Maclennan (1991) defined Post-Occupancy Evaluation (POE) as a performance evaluation, which is a method of supplying decision makers with the necessary information about a building in use based on reliable data. The evaluation of a building is focused on four sections that include; measurement of criteria, comparison of the measurement, evaluation of the measurement, and finally feedback (Maclennan 1991). Maclennan (1991) argued that in order to evaluate a building in use, four categories are required in the process, which are represented by: technical category, statutory, functional, and behavioural. Regarding the technical category, which is about the building components such as the structure materials, finishes, ventilation system, light and others. As to the statutory category, it encompasses all the regulations and standards of health and safety in a building. The functional category is mainly about the criteria that have been established by the client in the brief at the beginning of the project, in this category the client will check whether the requirements have been achieved or not. Finally, the last category understands the behavioural aspect, which is related to the psychological and sociological impacts of the building design on the users (tenant or maintenance staff).

The most concerned stakeholders in the success of a building in use are Facility mangers (FM), and POE method can clearly help FM to make decisions as well as other benefits such as:

- Increase their professional standing by having replicable measurements for evaluating the success of their work;
- Understand the relative trade-offs for spending decisions;
- Objectively compare buildings in a property portfolio and,
- Be provided with the information on which sound business decisions can be based (Maclennan 1991).

Hay et al. (2018) adopted two-part definitions of POE in their research. The first part is concerned with the quality and standards of design and construction, which includes space planning, external, and internal environment quality, maintenance and occupancy costs, user comfort, shortcomings, etc. The second part is concerned with the continual learning and dissemination process of POE knowledge for designing future architectural projects purposes (Designing Buildings Wiki 2016). Hay et al. (2018) analysed POE within five contexts; including definition, valuing, barriers, embedding, and developing POE. As to the definition of POE, the sample used in their study agreed on one simple meaning to it, which is the understanding of a building performance after use, and the lessons acquired from it, that could help in improving other future designs (Hay et al. 2018). Zimring and Reizenstein (1980) have defined post-occupancy evaluation (POE) as "examination of the effectiveness for human users of occupied design environments". Nicol and Roaf (2005) made a comparison between POE and field studies of thermal comfort (FSTC) in buildings; where they pointed out that POE focuses on human characteristics in evaluating the performance of buildings. POE is mainly concerned with the changing nature of the relationships between people, the climate and buildings. The problems and issues experienced within the building were retrieved by Preiser (1995) and are listed below:

- health and safety problems,
- security issues,
- leakage,
- poor signage and wayfinding problems,
- poor air circulation and temperature control,
- handicapped and accessibility problems,
- maintainability of glass surfaces (e.g. skywalks or inaccessibility skylights),
- lack of storage,
- lack of privacy,
- hallway blockage,
- aesthetic problems,
- inadequacy of designing space for equipment (like copiers),
- entry door problems with wind and accumulation of dirt.

In the 1960s, the first POE endeavours involved college dormitories evaluation, due to their availability to university researchers, in addition to similar studies, which led to significant findings that are; inefficiencies, misfits between occupant and buildings, as well as strong connection between building configuration and the social relationships. By the early 1970s, the first collaborations between architecture and medicine were reported, and the evaluation of care facilities addressed some criteria such as staff travel time, proximity of hospital functions, time spent at patients' bedsides, and differences in staffing requirements and efficiency (Preiser et al. 2015). The 1970s was a period of change in the construction industry, where POE activities became more considerable in terms of methods used, building performance, and building users (Preiser et al. 2015). In fact, there was more focus on the users' satisfaction rather than the physical environment, which changed in 1980s, where an important model of how the physical environment and organisational setting could influence the workers' behaviour and perspective, has been developed by Marans and Spreckelmeyer (1981).

Deuble and de Dear (2014) explained that systematic information on building performance from an occupant's perspective could not be easily accessible until 1950s. In 1960s, the UK witnessed a rapid growth for architectural projects, where the Royal Institute of British Architects (RIBA 1962) identified the need to capture and disseminate information and experience based upon the requirements of building occupants. Indeed, the RIBA made it necessary to study the buildings, which have been occupied in terms of design, cost and technical aspect (RIBA 1962, Cooper 2001, Derbyshire 2001). The RIBA's Handbook of Architectural Practice and Management (RIBA 1965) was an efficient instrument that identified the construction projects' stages order, which include briefing/programming, design, specification, tendering, completion and use (Cooper 2001, Preiser and Vischer 2006, Preiser and Nasar 2008). This report included another stage called "Feedback", in which architects would inspect their completed building in order to improve the service for future projects and clients (Preiser 2001, Bordass and Leaman 2005). As a result, the concept of POE appeared and started to be used; however, it was ignored by the design and construction industry in the UK, due to its potential of delivering evidence and proof to the clients about design underperformance (Cooper 2001, Hadjri and Crozier 2009). In the 1970/80/90s, other countries started using the concept of POE to study their houses including the USA, Australia, and New Zealand; POE gained more credibility and reliability as a scientific tool for user satisfaction within buildings (Preiser 2001, Vischer 2001, Bordass and Leaman

2005). As to the UK, in 1990s, POE started to be considered as a potential tool to evaluate the building and achieve clients' requirements (Cooper 2001). Preiser et al. (2015) further stated that POE's purpose would provide a database of lessons learned through a feed-forward concept based upon a detailed review of the completed buildings, which will help in using the best practices for future projects. In addition to other purposes stated by The Federal Facilities Council & National Research (FF Council 2002), who argued that post-occupancy evaluation's purpose depends upon the client organisation's aims, objectives and needs. These several purposes could be to provide the following:

- To measure whether the design is functional and appropriate and to conform it with the requirements stated in the functional program;
- To fine-tune the facility, in other terms, to make the building flexible and adaptable to any necessary changes that meet the requirements and needs of the organisation;
- To adapt programs and identify design solutions for repetitive facilities that have repetitive design;
- To look for the effects that a building can have on their occupants through a thorough research involving precise measure and sophisticated levels of data analysis, that includes factor analysis, cross-sectional studies in order to get general findings;
- To check the application and working of any new concepts that leads to a good practice and,
- To justify the expenditures and actions undertaken by organisations through a generation of the necessary information to accomplish this objective.

De Wilde (2014) argued that performance gaps could be similar between the predicted and measured ones, that includes indoor air quality, thermal comfort, acoustic performance, daylighting levels, and other criteria related to quantifiable aspects of the building. Van den Brom et al. (2018) have argued that the discrepancy between the calculated and actual energy in the building, is called the "energy-performance gap". In other terms, the difference between the actual energy, which is measured by energy distribution companies and theoretical energy consumption that is calculated itself by the energy label is considered as the "energy-performance gap" (Van den Brom et al. 2018). Majcen et al. (2013) demonstrated that occupants of buildings that are energy-inefficient consume less gas in heating and water utilization than expected, while occupants of buildings that are energy-efficient consume more gas than expected, in addition to the gap between theoretical and actual electricity consumption. In addition to the performance gap, which can occur between the design expected to be realised and the building performance due to construction mistakes, failure in the design, management or unclear use of building (Loftness et al. 2009).

According to the Royal Institute of British Architects (RIBA 2013), a building should go through seven stages which are strategic definition, preparation and brief, concept design, developed design, technical design, construction, handover and close out, and finally in use. The post-occupancy evaluation occurs at the in use stage, where facility managers check the adaptability and sustainability of the building according to the comfort and functional aspect of the space designed. In addition to this, POE needs to check the disparity between the expected energy to be used and the energy already used in the building. Furthermore, Devlin and Arneill (2003) conceded that POE has tremendous benefits, designers need to acknowledge and support in their designs, this was also supported in many research works (McLaughlin 1975, Zimring and Welch 1988).

2.4 HEALTHCARE USERS' PERCEPTION OF THE DESIGN OF HEALTHCARE FACILITIES

Proverbs et al. (2000) stated that the UK construction industry suffers from different problems such as the low profitability of the industry, the shortage of resources, the fragmented nature of the industry, the one-off nature of construction projects, and so on; the consequence to these problems is a dissatisfaction of the client. Users' opinion has been an important factor upon which architects and designers focus. Andrade et al. (2012) argued that the design of hospitals depends upon the views of experts such as architects, administrators, construction engineers, policy makers and politicians; however, the perception of users is vital in the success of the building and its value. Stern et al. (2003) highlighted the importance of users' satisfaction that help in achieving great performance of the design and meeting the expectations.

According to Elf et al. (2015), the satisfaction/dissatisfaction of users stems from the design of HCFs, as inadequate designs could result in major and critical issues such as patient falls and infections as well as patient dissatisfaction. They also pointed out that the architecture of healthcare is challenging when it relates to taking into consideration the users' views for the design-decision. Elf et al. (2015) argued that it is possible to improve the buildings' positive outcomes by involving patients, staff and designers, and added that evaluations would be beneficial in obtaining knowledge and experience of the working environment. Mourshed and Zhao (2012) investigated the perceptions of users regarding the design indicators of the inpatients' environment. They found out that users were satisfied with the cleanliness aspect first followed by thermal comfort, prevention of falls, smell and odour, lighting and finally

noise respectively. Mourshed and Zhao (2012) added that users were not really concerned with the spatial design more than the environmental aspects; nonetheless, entertainment facilities, views and space customisation were still deemed important to them. Caixeta et al. (2013) used a diagram to describe the process of exchanging information between both designers and users and the way designers make their decisions based upon the users' opinions (see Figure 2.3).

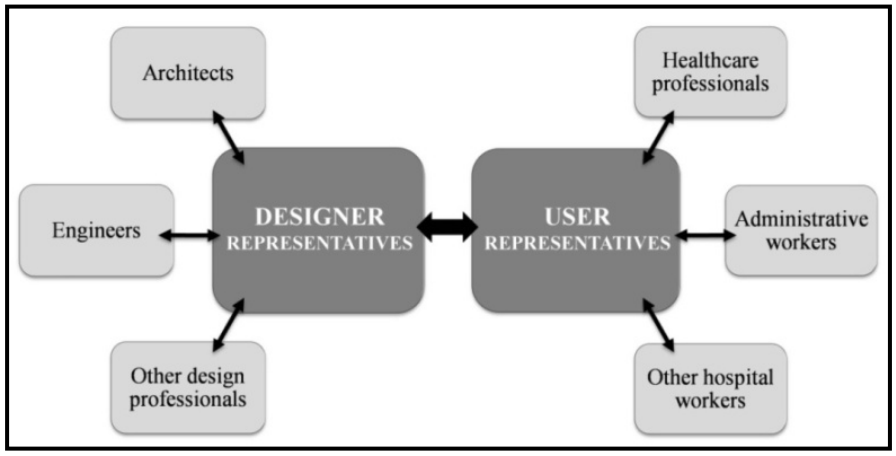

Figure 2.3: Designers and users groups representation (Caixeta et al. 2013).

In this research, the focus was based on architects and healthcare professionals as illustrated in the figure below (Figure 2.4)

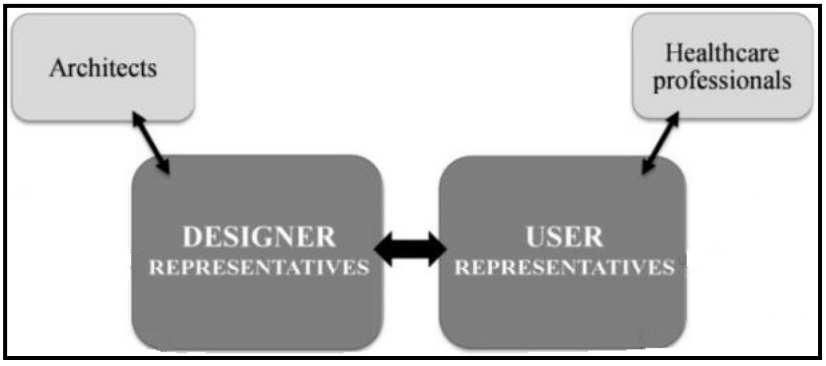

Figure 2.4: Designers and users groups adopted for the research (Caixeta et al. 2013).

2.5 THE GAPS OF MEETING THE EXPECTATIONS

Kujala (2003) demonstrated that users' satisfaction could be one of the benefits of early users' involvement. He argued that early involvement of users may have a positive effect on the end-product; yet through better user requirements that help in the enhancement of the quality system as well as more innovation (Kujala 2003). Lack of feedback from users is one of the factors that hinders the delivery of better designs.

Perceptions of users may vary from their expectations, as HCFs may be poorly designed, hence failing at meeting the expectations of users or suitably designed and perfectly meeting their expectations. Moreover, the failure of meeting the expectation could be a consequence of lack of communication between designers and users or the misinterpretations of the users' needs (Chandra and Loosemore 2011). Additionally, the use of technology could enhance the delivery of HCPs, yet designers do not always consider using the emerging technologies that may help in enabling designs to be standardised such as Building Information Modelling (BIM). BIM has contributed significantly in the development of computer-generated n-dimensional (n-D) in the Architecture, Engineering, and Construction (AEC) industry. Azhar et al. (2008) identified the potential benefits of using BIM as; faster and more efficient processes, a better design, a control over the whole project lifecycle, better quality, automated assembly, accurate visualisation, and better understanding for clients and users. Manning and Messner (2008) have witnessed benefits in the use of BIM on healthcare projects. These include the rapid and instant visualisation of spaces, accurate updates of changes provided to the project, increased communication, confidence, and information to help support decisions made during the project lifecycle. Alfonsi et al. (2014) argued that the use of evidence-based design in healthcare facilities can reduce the spread of infection in hospitals, stress and injuries on medical staff, and improve the healing of patients. Recently, an increasing number of designers started using BIM (see, for example, (NBS 2019) and its potential for use as a design knowledge repository for evidence-based design increases. Ganiyu and Egbu (2018) have proposed a preliminary framework (BIM-K) that integrates tacit knowledge in BIM implementation, using as KM process in order to facilitate the integration. Ultimately, there is potential for the supplementing of evidence-based design by drawing upon such a BIM-enabled knowledge base.

The table below discusses the thematic presentation of extant research and the research gaps to support the problem statement, objectives and knowledge gaps.

Key references	Ref 1 Phiri (2014)	Ref 2 (Rashid 2013)	Ref 3 Ulrich et al. (2008)	Ref 4 (Li and Zhang 2013)	Ref 5 (Hay et al 2018)	Ref 6 (Andrade et al 2012)
Research core	the design issues and design principles	benefits of implementation of EBD in HCFs	Outcomes of EBD on patient's safety	Importance of knowledge in designing HCFs	Use of POE in their research	Users' perception from HC buildings
Knowledge Gaps	The update of guidance	Limitation of EBD	Shortage of evidence	Lack of sharing the knowledge	Lack of capture of lessons learnt	Lack of involvement of users

Table 2.1: The gaps of research in literature review.

The figure below is an information-flow based upon the literature review.

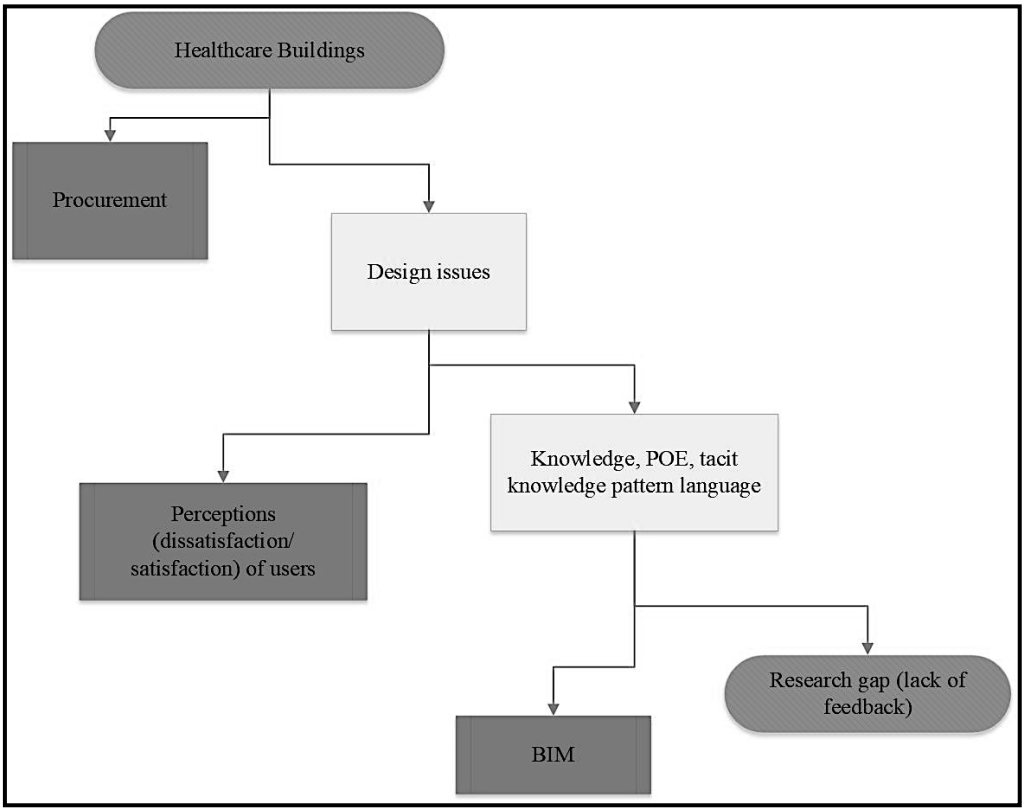

Figure 2.5: The information flow based upon the literature review.

2.6 SUMMARY

An extensive literature review has been undertaken in regards to the design of healthcare facilities, along with their design issues and the guidance used by designers. The design guidance of HCFs was divided into sections of evidence-based design, knowledge, pattern language and post-occupancy evaluation. These were explained in details, to demonstrate the relationship between the design of the healthcare premises and the use of guidance. A discussion was followed on the healthcare users' perceptions of the design that result in a dissatisfaction or satisfaction resulting in the gaps of meeting the expectations of users. The next chapter will discuss the methodology used to meet the aim and objectives of the research. It will also include descriptions of the research design as well as the research methods used for conducting the data collection.

CHAPTER THREE

3 RESEARCH METHODOLOGY

3.0 INTRODUCTION

This chapter outlines the research methodology for this study. Mixed-method research that consists of a qualitative and a quantitative approach will be set out. The chapter identifies the types of data collection required to address the aim and objectives (see Chapter 1) of the PhD research. First, the chapter explores the research methodologies used in different research works. Second, it discusses the research methodology that is used in the context of this research study, followed by the research methods that are considered. Finally, the methodological framework that is undertaken will be discussed, then the chapter will summarise all the discussed elements and introduces the insights of the next chapter.

3.1 AN OVERVIEW OF RESEARCH METHODOLOGIES

Clough and Nutbrown (2012) defined research as the exploration and investigation of a specific idea to an ad-hoc context. Furthermore, they stated that research is carried out to achieve a certain knowledge and awareness of an idea and meaning related to a specific topic of interest. During the research, some questions are articulated to get answers, and the methodology is set out to show how those research questions are articulated with the questions asked in the area of interest. Research is generally deemed to identify something new that might be new knowledge or piece of information for one person or a large number of people (Petre and Rugg 2007). Two sources of research data exist: primary and secondary research are explained by Petre and Rugg (2007). The primary research involves a new research outcome that has been discovered for the first time by a person or a group of people; unlike secondary research, which has been discovered by some people, albeit it could be new to others. According to Petre and Rugg (2007), secondary research is important for carrying out the primary research; moreover, it will lead to avoid reinventing the wheel. Although the importance and usefulness of secondary research, the primary research still plays the biggest role in the research and answers the most important questions (Petre and Rugg 2007).

Petre and Rugg (2007) further stated that research is mainly about exploring new knowledge and what has not been revealed yet and to achieve the final results, and outcomes of the research, some stages need to be undertaken that include the machete stage, detailed stage, and finally the theodolite stage. Petre and Rugg (2007) explained that the questions at the first stage, which is the machete stage, are superficial and general such as the "what" questions. However, the second stage tends to be more developed and detailed instead of simple observation, while the third and final stage (theodolite stage) focuses on answering the questions accurately and achieving fine, accurate, and precise details. According to Kumar (2014), the definition of research may vary depending on the expert and discipline perspective. Research in the social sciences is divided into three main perspectives. These are applications of the findings of the research study, objectives of the study, and mode of enquiry used in conducting the study. Kumar (2014) explained that research could be viewed and classified from different perspectives; in other words, research may be classified as pure or applied research from the perspective of applications. It is classified as correlational, descriptive, exploratory or explanatory research from the perspective of the objectives of the study.

Research design is the road map followed during the research undertaken to find answers to the research questions in an objective, accurate, valid and economic way (Kumar 2014). It is the plan conceptualised by the researcher attempting to give answers to the research questions and aims to develop and identify procedures and logistical arrangements. Additionally, it emphasises the importance of quality in those procedures to ensure their accuracy, validity, and objectivity (Kumar 2014). Several research methods for collecting data could be used in research. They could be used within different approaches of study, such as quantitative and qualitative. Data could be obtained through either primary sources or secondary sources. Secondary data are available in documents such as government publications, previous research works, census, personal records, client histories and service records. On the other hand, primary data may be used by observation, interviews or questionnaires. Observation could be participant or non-participant, as for interviews that could be structured or unstructured, and for questionnaires, it could be mailed, collective or online questionnaires (Kumar 2014). Flick (2015) defined social research as an analysis of the research questions using methods based on questions, observation, and data analysis. According to Flick (2015), social research has become a major basis to make decisions within a practical and political context.

Social research is used to explore issues and provide description, discover new relations by analysing data, provide empirical data and analyses to develop theories (Flick 2015). Furthermore, social research can provide knowledge, such as data analysis and results. However, it might not find immediate results for urgent problems as limitations. Knight and Ruddock (2009) summarised the methodologies that could be adopted in four ranges; the first one is quantitative research where quantitative methods will be used in a positivist research paradigm. The second one is qualitative research, where qualitative methods will be used in an interpretative research paradigm, while the third one is a mixed-method combining both inductive and deductive research approaches. Creswell and Creswell (2017) explain that within quantitative strategies; two types of research could be done that are survey research and experimental research. The survey research involves a study of a sample, for example, a population by extracting a quantitative or numeric description of their opinion about a specific topic, while the experimental research is about true experiments in a field of interest. On the other hand, qualitative strategies include five strategies that are ethnography, grounded theory, case studies, phenomenological research and narrative research (Creswell and Creswell 2017). Finally, the last range, which is mixed- method strategy that encompasses sequential mixed-methods, concurrent mixed-methods and transformative mixed-methods.

3.2 RESEARCH PHILOSOPHIES

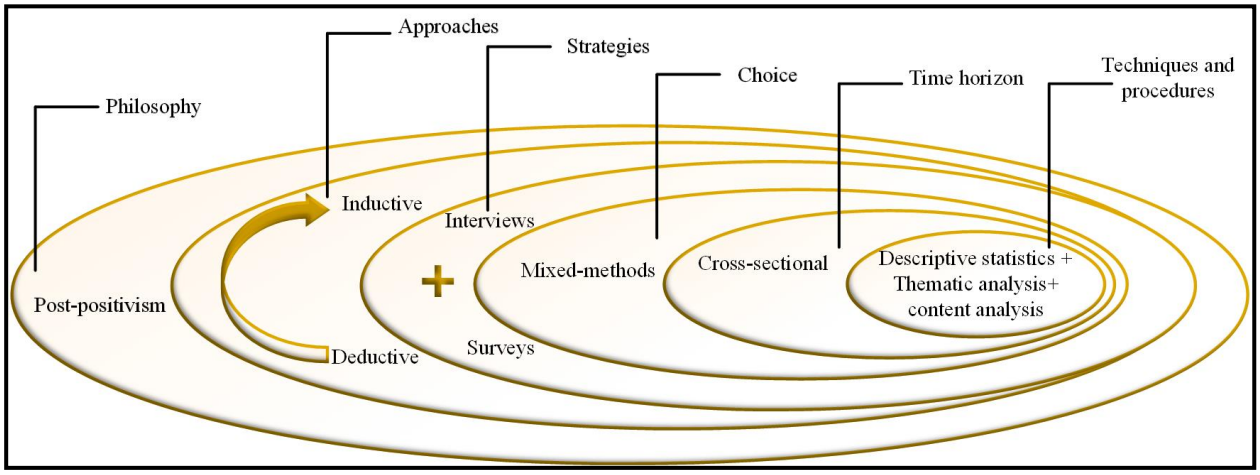

Figure 3.1: The research methodology extract adapted from (Saunders et al. 2009).

Crossan (2003) explored the important reasons for studying research philosophies and explained their relationship with the research methods. As to the reasons cited by Crossan (2003), research philosophies can help in identifying the research methods used by the researcher and the ability in answering the research questions.

Moreover, the researcher gains the ability to distinguish between the uses of different research methodologies and chooses the appropriate one for the research at an early stage. In addition to the previous reasons, Crossan (2003) added that the researcher becomes creative and innovative by choosing or adopting one of the research philosophies and methods for the research, as well as gaining additional experience and knowledge. Each research philosophy is concerned with the way of conducting research by focusing on the research questions, research objectives, research strategies and instruments used to find out the answers about a specific topic. There are three ways of thinking about research philosophy: ontology, epistemology and axiology. These concepts or ways of thinking help the researcher in viewing the research from different angles and these ones relate automatically to the research approaches and research methods. Saunders et al. (2009) defined ontology as an assumption that is related to the nature of reality and social beings, which includes two aspects that are objectivism and subjectivism. According to Allen and Varga (2007), ontology is about the outside view and the reality of findings that researchers try to achieve. Moreover, ontology is concerned with the nature of existence and the evidence of proving that the topic is real and tangible; whereas epistemology is concerned with what is acceptable as knowledge and the ways of validation (Saunders et al. 2009, Bryman 2012).

For instance, in the case of a pyramid, the ontology needs to explain what is a pyramid? while, epistemology deals with the methods and ways of getting to know a pyramid and the question asked is how do we get to know if it is a pyramid or not? According to Scotland (2012), research paradigm consists of four components that are ontology, epistemology, methodology and methods. Slevitch (2011) explains what a paradigm is and how it is related to ontology and epistemology assumptions; indeed, a paradigm is described as "a cognitive perspective or a set of shared beliefs to which a particular discipline adheres". Morgan and Smircich (1980) argued that any research method that has been undertaken within research is crucial and important to understand as a real subject, as it encompasses different assumptions, which help in obtaining knowledge and the methods used to achieve it. Research philosophy is a vast domain that deals with the way of collecting data, analysing and using it afterwards. Saunders et al. (2009) have identified different types of research philosophies and among them pragmatism, interpretivism, realism and positivism in addition to post-positivism and constructivism (constructionism) (Bryman 2012). Regarding the research onion as illustrated by (Saunders et al. 2009), this research adopted a category in each layer as illustrated in (figure 3.1).

As to the first layer, which is represented by research philosophies that are positivism, post-positivism, realism, interpretivism and pragmatism (Saunders et al. 2009). This research followed a paradigm regarding the objectives and research methods to be used and according to the literature review, where positivism is known to adopt the natural scientist perspective, where a positivist uses existing theories in order to develop hypotheses that are either confirmed or rejected at the end of the data collection (Saunders et al. 2009). In a positivist approach, the researcher does not affect the results, nor do the outcomes of the research influence the researcher. The positivist philosophy emphasises the quantifiable data, which leads to a statistical analysis, the analysis of the data is done in an isolationist way and reductionist without incorporating the researcher's views and personal opinions. Whereas, interpretivism (anti-positivism) is the opposite of the positivist approach; and deals with humanistic methods such as interviews and participant observation, which is related to the qualitative method (Saunders et al. 2009, Bryman 2012). The epistemology related to this philosophy is subjectivism, where the researcher is supposed to interpret the results in a subjective way in a holistic and contextual analysis. In other terms, the researcher must be part of the study through his/her comments and additional opinions.

Another philosophy has emerged from the positivist approach, which is called post-positivism, and opposed to the positivist approach, post-positivism allows researchers to include their opinions and their backgrounds, knowledge, values or even theories which can affect the results and outcomes of the data collection (Crossan 2003). The post-positivism approach combines both positivist and interpretivist views; however, it considers that reality can be created and constructed by researchers rather than tested as true evidence. This research does not follow only one typical paradigm (positivist or interpretivist) but supports another choice of philosophy, which is post-positivist as this latter combines both two previous approaches and tries to transform their weaknesses into strengths in this approach. Post-positivism relies on research approach that starts with a theory, then collects data that either supports that theory or rejects it, which leads to other tests (Creswell 2014). In contrast to other philosophies, post- positivism is underpinned by the use of mixed-method approach (Giddings and Grant 2006), which is the choice adopted for this study. The second layer of the research onion is related to research approaches including deductive and inductive approach. A deductive approach commences by setting up theories and hypotheses that are tested and confirmed through the data collection; while the inductive approach is to start up with observation and collection of data that lead the researcher in generalizing the

outcomes as theories (Bryman 2012). This research follows first a deductive approach then follows it up with an inductive approach, in other terms, the researcher starts by sending out an online survey in order to gather the data regarding the design issues in hospital wards. The data collected from the surveys are then used in producing interviews to confirm the theory that is already put, which leads to an induction approach, although it is not purely inductive. The third layer consists of the research strategies, which imply the use of methods in collecting data (Saunders et al. 2009). The strategies in this research consist of surveys and interviews, followed by the fourth layer, which is a mixed method that combines the use of e-surveys and interviews. This research is a cross-sectional study because it studies a typical phenomenon in a time. Cross-sectional studies are related to the survey strategies, as well as the use of qualitative approaches that are based on case studies, in which they use interviews that are undertaken over a short period of time (Saunders et al. 2009). Unlike the longitudinal studies that undertake a study over a long period, having the ability to study change and development. Regarding the analysis of quantitative data, it is going to be statistical and thematic; whereas the qualitative data is going to be verbally transcribed, which is content analysis.

3.3 RESEARCH METHODOLOGY FOR THIS STUDY

According to Johnson et al. (2007), the use of quantitative research at the first stage can help in identifying the representative sample members in the qualitative research afterwards; whereas the qualitative research data can help in improving and developing the use of instruments in the quantitative research. At the data collection stage, the quantitative approach is important in order to specify and identify the background of information needed to undertake the research, as well as limiting the group of samples and the qualitative approach facilitates the process of collecting data (Johnson et al. 2007). Once the data analysis commences, the quantitative data can help in the evaluation of qualitative data and its generalizability and may help in discovering new findings. On the other hand, during the qualitative data analysis, results from quantitative research are interpreted, clarified, described, validated and possibly modified. Rossman and Wilson (1985) identified different reasons for using combined methods (mixed-methods). One of the reasons is the corroboration and confirmation of the data gathered from each approach and this is through the triangulation concept, the second reason is to develop an analysis for richer data, and finally new methods may emerge from the combination of two paradoxes of thinking. Azorín and Cameron (2010) argued that a mixed-method is used in order to fully address the

research problem and questions. Regardless of the barriers and obstacles that hinder the conduction of mixed-method, which is due to the tight schedule, workload, financial resources and the publication of results; the combination of both approaches (quantitative and qualitative) has been considered beneficial for its multiple advantages (Azorín and Cameron 2010). Among the advantages of the mixed- method that it provides a broad and complex understanding of the phenomenon studied, as well as a better understanding through the triangulation concept; which is defined by (Jick 1979, Tashakkori et al. 1998) as a strong tool that overcomes any weaknesses derived from single methods. The mixed-method offers the ability for researchers to feel more confident about their results as far as being valid (Niglas 2004) cited in (Azorín and Cameron 2010). Furthermore, the mixed methods allow the researcher to achieve complementarity, development, initiation and expansion; in fact, the results obtained may be confirmed from the use of one method and are clarified from the other method. One single method can answer the research questions; however, it will lack the validity option from the use of another method, which is one of the main benefits of mixed-methods. The methodology that has been undertaken for this research is a combination of both qualitative and quantitative approaches; the table below illustrates the main characteristics and differences between them according to the literature review (Saunders et al. 2009, Bryman 2012).

Quantitative Approach	Qualitative Approach
Deductive strategy	Inductive strategy
It tests theories based on literature review to build data	It builds theories based on the results of data collection
Large sample	Small sample
It focuses on scientific principles, and treats results objectively	It focuses on the interpretation of results given by human beings
Generalizability of data	Specificity of data
The separation between the researcher and the researched concept	The research is part of the researched concept
Exploratory research	Descriptive and Explanatory research
Data depends on quantity, and is represented by numbers, figures and statistics	Data depends on quality of results and is represented by words, pictures, diagrams
The use of surveys and questionnaires	The use of interviews

Table 3.1: The differences between qualitative and quantitative approach [Adapted from (Saunders et al. 2009)].

The use of combination should be undertaken in a simultaneous way, sequential or dominant. As argued and demonstrated by many researchers (Johnson et al. 2007) (Azorín and Cameron 2010) that it exists different types of mixed methods research, which are QUAN+qual research, QUAL+quan research and Equal status. The first type is recognised to be quantitative dominant research where qualitative approaches are added to benefit the research results, while the second type of mixed methods research has qualitative research as a dominant approach, where the researcher includes quantitative approaches to the research. Finally, the equal status, which includes both quantitative and qualitative approaches that are used simultaneously "QUAL+QUAN". This research starts first with a quantitative approach followed by the qualitative approach, which leads to a sequential design, as to achieve an exploratory understanding of the studied phenomenon followed sequentially by an explanatory and a descriptive clarification of the phenomenon.

3.4 RESEARCH METHODS

According to McQueen and Knussen (2002) there is a diversity of research methods to be used in any type of research that help in addressing the issues, exploring, examining, describing, and drawing conclusions. These research methods vary from one to another, based on their way of conduction, ability to answer research questions and their processes, which include diaries, observation, interviews, case studies, surveys, experimentations, field experiments and quasi-experiments, in addition to action research, grounded theory, ethnography and archival research as identified by (Saunders et al. 2009). In order to be able to achieve the aim as well as the research objectives, this research adopted two types of strategies that are questionnaires and interviews. Regarding the questionnaire a self-administered Internet-mediated questionnaire, which will be sent electronically through the Internet to the selected samples. These questionnaires will include rating scale, Likert-scale and open-ended questions. The questions will be assigned to two different samples (explained in the section below) and will be analysed statistically and thematically. Saunders et al. (2009) argued that there are two groups for quantitative data that are: categorical and numerical, categorical are divided into two groups including descriptive and ranked. As to numerical data that are divided into two groups continuous and discrete. The second type of strategy that will be used is a non-standardised semi-structured interview. The interviews will be a one-on-one face-to-face interview. These interviews will be allocated to one sample following-up the surveys. These interviews will be analysed as a content analysis in a descriptive format.

The table below illustrates the link between the literature review undertaken for the research and the data collection methods.

Key Knowledge gaps identified in the Literature review	Data collection methods
The design issues and design principles	Survey of designers
Users' perception from HC buildings	Survey of healthcare users
	Survey healthcare users (Academia)
Benefits of implementation of EBD in HCFs, Importance of knowledge in designing HCFs	Interviews of designers

Table 3.2: Linkages between literature review and data collection.

3.5 TECHNIQUES AND IMPLICATIONS OF SAMPLING

In order to conduct research, there is a need to select participants (respondents). These participants are going to be sampled and categorised in groups, either randomly or purposely. There are two main types of research sampling that are probability and non-probability sampling (McQueen and Knussen 2002, Saunders et al. 2009, Bryman 2012). Saunders et al. (2009) argued that probability sampling or representative sampling means that the chance or probability of the selected population is known and could be equal to all cases chosen, it is also mainly associated with experiments and surveys. On the other hand, the non-probability sampling does not allow the researcher to have an idea about the probability of cases derived from the population, as this is unknown. Five categories fall under the probability sampling that is simple random, systematic, stratified random, cluster and multi-stage sampling. Regarding the non-probability sampling, which includes these different samplings: quota, snowball, convenience, self-selection, and purposive (extreme case, heterogeneous, homogenous, critical case and typical case). Saunders et al. (2009) explained that quota sampling is usually associated with the surveys. For this research, two categories of samples are required: the designers and the healthcare users (clinicians and nurses and allied health professionals). Two-targeted population were used in this research following a stratified sampling that divided the population into two strata; the first one is designers and the second is healthcare users. The sampling that is used with the first population 'designers' is a random sampling from architectural practices (who specialise only in the healthcare sector) to send them surveys. The researcher identified the samples from architectural resources such as Royal Institute of British Architects 'RIBA' website, by calling and emailing all healthcare

architectural practices. The other sampling that was used after having tried the random sampling is the snowball as some designers referred the researcher to other design companies who specialise in the healthcare sector. The interviews that followed the surveys were undertaken based upon the acceptance of designers to do follow-up interviews in the last section of the survey. The sampling that is used with the second population 'healthcare (HC) users' is a non-probability sampling that combines both snowball and convenience sampling from HC users in (academia and third sector) and (hospitals) respectively. HC users were divided into two groups; the first group was (nurses, doctors and allied health professionals who used to work in hospitals and moved to academia, research and the third sector), the second group was (HC users still practising in hospitals).

3.6 ETHICAL CONSIDERATIONS

Saunders et al. (2009) emphasised the importance of research ethics, stating that ethical concern arises in the case of bad behaviour regarding the participants of your research. Indeed, a definition has been given by (Cooper and Schindler 2008) who explained that ethics is "norms or standards of behaviour that guide moral choices about our behaviour and our relationships with others". In fact, the ethical issues have been taken into consideration by the researcher to be in accordance with the research ethics at the University of Northumbria. This research deals with two-stage ethical applications, the university research ethics and NHS ethics. The first level was taken in order to deal with two clusters (designers and healthcare 'HC' users (working in the academia and the third sector); while the second level of ethics is to deal with the third cluster who are healthcare users (clinicians and nurses working in the hospital). The university ethics have been sent several times to the reviewers in order to start the data collection with designers and healthcare users (working in academia) because of the level of risk (red because the research works on healthcare premises) which was supposed to be green as it did not involve vulnerable people (children or patients). The NHS procedure involves time-consuming steps. The IRAS (Integrated Research Application System) has been sent twice to the NHS reviewers, which is a form that consists of multiple pages where the researcher must complete all sections related to the research process as well as the participants and the sponsoring of the research. Once the NHS ethics were approved, other documents were asked to be submitted to the assessor, who then requested to send another set of documents, which is called local pack of information to the NHS research and development team in order to be able to get access to hospitals and the users (a badge). The researcher prepared written consents and participant information sheets where the participants

are informed about the research ahead before they start filling the questionnaire as well as their consent to be part of the research.

3.7 CREDIBILITY OF RESEARCH FINDINGS

Saunders et al. (2009) argued that two important factors should be taken into consideration that is reliability and validity. That is to say, the research findings should be consistent and this involves the stability, internal reliability and inter-observer consistency (Bryman 2012). However, the reliability factor can be affected by four threats that are a participant error, participant bias, observer error, and observer bias (Saunders et al. 2009).

Research findings should be measured in order to identify them as consistent and reliable, in fact, their ways can confirm whether the finding is reliable and consistent, which include test-retest reliability, alternate form reliability and split-half reliability (McQueen and Knussen 2002). In this study, reliability was addressed by having mixed modes of data collection (survey and interview). Concerning the validity of findings, which refers to the validation of the data collection and the ability to answer research questions, this was addressed by exposing the product of the research to scrutiny by experts in the field.

3.8 METHODOLOGICAL FRAMEWORK

The methodological framework that is followed for this research is illustrated in the figure 3.2 below, as it starts with the idea of a research topic in order to start the research process. Once the idea is triggered, the literature review process starts, which leads to the data collection that is chosen based on the philosophy's assumptions. In this research, two types of approaches are used that are quantitative approach and qualitative approach and both are administered to different categories (samples). After the data has been collected, the research performs the quantitative analysis and qualitative analysis. The findings help in developing a conceptual framework, which eventually will validate the theory of this research. Finally, the research concludes with recommendations for further works in the future in order to improve the findings of this research or expand on them.

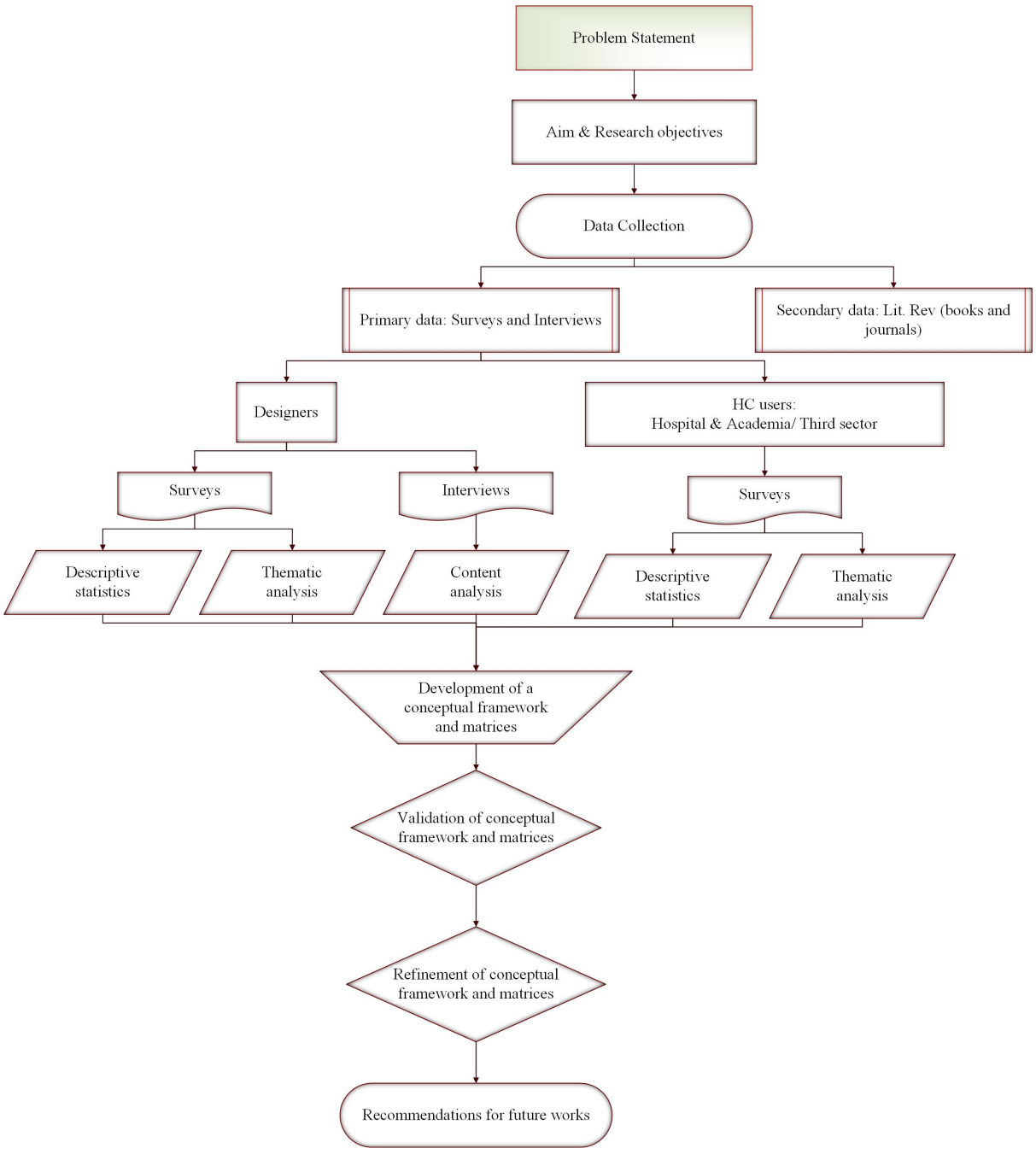

Figure 3.2: The methodological framework.

3.9 SUMMARY

The researcher needs to understand the topic by taking into consideration the research objectives alongside the research questions. Yet but most importantly, the ultimate question is what needs to be discovered at the end of the research process. Despite the heavy outcomes of every single method, mixed-method research is becoming increasingly used by researchers for its positive benefits and results.

This chapter demonstrated the use of research methods and the concept that follows ontologies and epistemologies. Indeed, the research combined quantitative and qualitative approaches from which both results can be accurate and rich. The chapter illustrated the research methodology adopted and the ability of the combination of research methods to answer research questions and meet the research objectives. According to the extensive literature review, it is clearly argued that research needs to be conducted according to its philosophical assumptions in order to reach the knowledge aimed to obtain at the beginning of the research process. The chapter discussed the research philosophy that has been adopted, which was followed by the research strategies subsequently. It has also discussed the sampling process in research and the ethical concerns that may occur during the process. As illustrated in different previous research works, the findings from the data collection must be tested to obtain their validity and reliability, in order to be considered as a reliable reference for future researches. The chapter concluded with the methodological framework used in this research briefly explained in order to leave the detailed explanation for the next chapter where it illustrates the data collection findings and their analysis.

CHAPTER FOUR

4 ANALYSIS OF SURVEY DATA COLLECTION AND RESULTS

4.0 INTRODUCTION

The previous chapter outlined the choice of a suitable methodology for this research. This current chapter analyses the data collected from the surveys. The first part of the data collection involved an online questionnaire assigned to designers, followed up by interviews. QuestionPro and Bristol survey have been selected to send the survey to designers and healthcare users, while the SPSS and NVivo to analyse and structure the data. The inferences tests have not been used because of their irrelevance to the research. The second part involved an online questionnaire assigned to healthcare users working in hospitals. These included staff (nurses, clinicians) and healthcare professionals who used to work in hospitals but had moved to academia and the third sector. First, the survey of designers is presented in two phases 'Descriptive Statistics' where the Likert-scale questions have been analysed and presented. The second phase is a 'Thematic Analysis' where the open questions of the designers' survey have been analysed thematically and presented. Second, the analysis of the healthcare' survey data is presented and this includes the statistical analysis followed by a part for three open questions. Finally, the chapter concludes with a summary that summarises the chapter content and introduces the next chapter content.

4.1 DESIGNERS' SURVEY ANALYSIS

The first questionnaire is a self-administered questionnaire that was assigned to architects via the Internet. This online survey consisted of 10 questions (2 ranking questions, 7 open-ended questions and 1 category question) as illustrated in the appendices. The purpose of the questionnaire was to retrieve information and knowledge from architects regarding the design of healthcare premises. Initially, the intention was to use a probability sampling however, this method changed to a non-probability sampling 'snowball' strategy due to the small number of architects working on healthcare projects in the UK. The same reasoning applied to the analysis of data, and this was restricted to descriptive statistical analysis on the basis that the sample responses represented a substantial proportion of the healthcare design

practices and precluded the need for inferential measures of representativeness. According to UK statistics, there were 54,000 architects in employment in the UK in 2018 (Statista 2019).

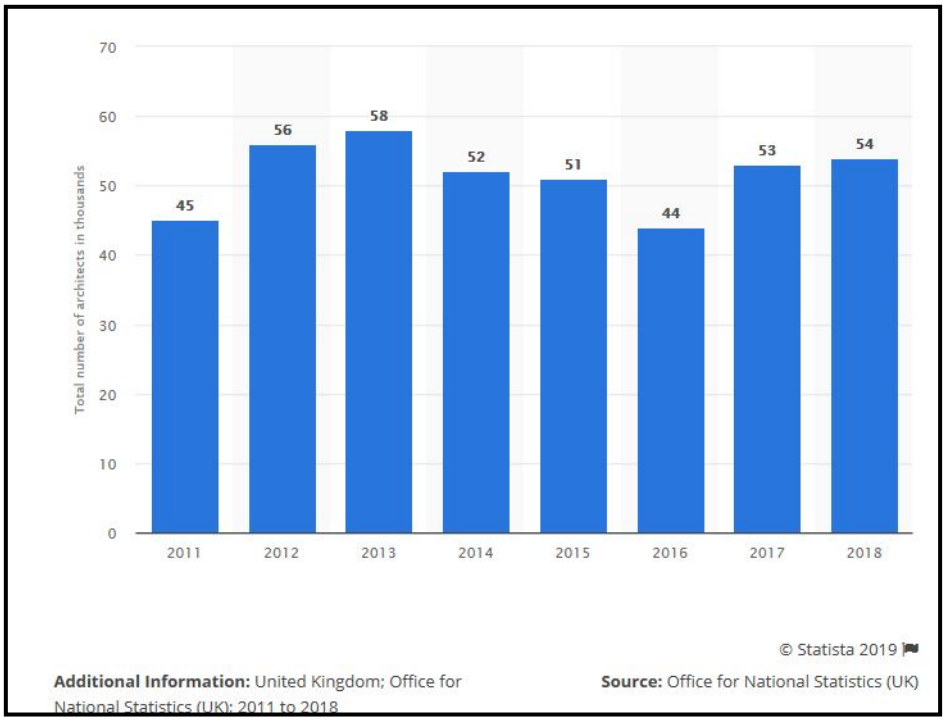

Figure 4.1: Statistics of architects in the UK (source: office for national statistics the UK)

4.1.1 DESCRIPTIVE STATISCTICS

Of these, one hundred and sixty-five (165) architecture practices who specialise in the healthcare sector were identified from the "Royal Institute of British Architects" (RIBA) and online search engines such as Google. The researcher also sent the survey on social media groups (Facebook, LinkedIn and Research Gate) that are involved in the design of healthcare premises, as well as bodies such as "Architects for Health". The overall number of responses reached 31, which is equivalent of 18% response rate and this was after several attempts, 70 architectural practices mentioned that they were not working in the healthcare sector anymore. While 95 architectural practices accepted to help in the survey and declined afterwards. As a result, 25 companies participated in the survey with thirty-one respondents; twenty-seven were architects practising in the UK in the healthcare sector, whereas two respondents were 'a building service engineer' and 'a structural service engineer'. The two other respondents who were not included in the analysis practised in other countries (Egypt and Turkey). Besides one of the architectural practices works only on hospices and healthcare centre as claimed by one of the respondents in the survey. The ranking questions (Likert-scale) and the category question were analysed using the Statistical Package for

Social Sciences (SPSS) by retrieving descriptive statistics. On the other hand, the seven (7) open-ended questions were analysed thematically and linked to the interview analysis that confirmed the data of the survey. The first question investigates the importance of the design issues in hospital wards by asking the participants about the most critical area in the design of hospital wards. The issues of designing hospital wards (Variables) were selected and chosen based on an extensive literature review and their relevance to the context (Department of Health 2008, Zhao 2013, Department of Health 2014, Alalouch et al. 2016, The centre for Health Design 2019). The survey was designed based on an online survey software called "QuestionPro". The intention was for surveys to take about 10 to 12 minutes to complete. The respondents were required to rank the 12 issues (Variables) retrieved from the literature review on a scale of 1 to 10 by moving the slider from the least important to the most important referred to as 10% to 100% in the survey respectively as shown in the figure below.

Question 1: What is the most critical area in the design of hospital wards?

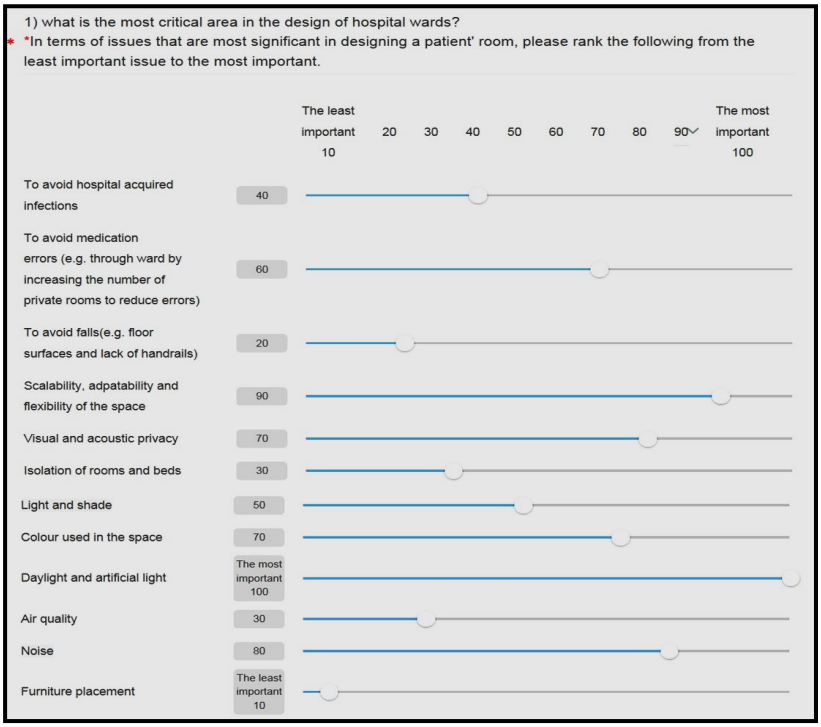

Figure 4.2: Screenshot of the first question in the survey (example).

The table below represents the data retrieved from the respondents according to each variable.

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*	*L*
N Valid	29	29	29	29	29	29	29	29	29	29	29	29
Missing						0						

Table 4.1: Sample size presented in the table with the variables.

Table 4.1 displays the sample size for the following Variables:

- ***(A) To avoid hospital-acquired infections,***
- ***(B) To avoid medication errors,***
- ***(C) To avoid falls,***
- ***(D) Scalability, adaptability and flexibility of the space,***
- ***(E) Visual and acoustic privacy,***
- ***(F) Isolation of rooms and beds,***
- ***(G) Light and shade,***
- ***(H) Colour used in the space,***
- ***(I) Daylight and artificial light,***
- ***(J) Air quality,***
- ***(K) Noise***
- ***(L) Furniture placement***.

There were 29 valid observations for all Variables. There were no missing values for any of the Variables. The following section will discuss the frequencies for each Variable mentioned in the first question above. The Variables are named as follows: Variable Designers 1 (D: designer; 1: question one; 1: Variable one) such as Variable-D-1-1 for question 1, Variable-D-2-1 for question 2, Variable-D-3-1 for question 3).

Variable-D-1-1: To avoid hospital acquired infections

The following table illustrates the frequency of responses for Variable-D-1-1 *to avoid hospital-acquired infections* on each scale.

Level of importance (%)	Frequency	Percent (%)	Cumulative Percent (%)	Interpretation
10	0	0	0	Relatively unimportant (The least important)
20	1	3.4	3.4	
30	0	0	0	
40	1	3.4	3.4	Moderately important
50	1	3.4	6.9	
60	1	3.4	10.3	
70	4	13.8	27.6	Very important
80	3	10.3	37.9	
90	4	13.8	51.7	
100	14	48.3	100.0	(The most important)
Total	29	100.0		

Table 4.2: Interpretation of the findings for Variable-D-1-1.

The respondents were required to rank at intervals of 10; therefore, the level of importance between Variables (12 issues) is shown as 10, 20 and 30 until 100, this is referred to as the 'relative importance index'. The request to respondents was that they should select from the least important (10) to the most important (100). However, for analysis, three importance intervals were created by grouping, i.e. from 10 to 30 labelled as 'relatively unimportant' (the least important), from 40 to 60 is labelled as 'moderately important', and from 70 to 90 labelled as 'very important' and finally 100 labelled as the 'most important'.

This is illustrated in the interpretation column in the figure above. As shown in the table, 14 out of 29 respondents (48.3%) emphasised the importance of Variable-D-1 (*to avoid hospital-acquired infections*) by selecting 100 on the sliding scale (translated into a score of 10 on the working analysis) while 11 respondents (37.9%) selected a scale of very important (70 to 90). The next category, 'moderately important', was highlighted by three respondents (10.2%) on a scale of (40 to 60). Finally, one respondent ranked Variable-D-1 as relatively unimportant (10 to 30); this respondent represents only 3.4% of the sample.

Variable-D-1-2: To avoid medication errors (e.g. through ward by increasing the number of private rooms to reduce errors)

The following table illustrates the frequency of responses for Variable-D-1-2 *to avoid medication errors, e.g. through wards*, *by increasing the number of private rooms to reduce errors* on each scale.

Level of importance (%)	Frequency	Percent (%)	Cumulative Percent (%)	Interpretation
10	2	6.9	6.9	Relatively unimportant (The least important)
20	2	6.9	13.8	
30	3	10.3	24.1	
40	2	6.9	31.0	Moderately important
50	2	6.9	37.9	
60	0	0	0	
70	2	6.9	44.8	Very important
80	3	10.3	55.2	
90	4	13.8	69.0	
100	9	31.0	100.0	(The most important)
Total	29	100.0		

Table 4.3: Interpretation of the findings for Variable-D-1-2.

As shown in the table, 9 out of 29 respondents (31%) emphasised the importance of Variable 2 (*to avoid medication errors, e.g. through wards by increasing the number of private rooms to reduce errors*), by selecting 100 on the sliding scale presented to them (translated into a score of 10 on the working analysis). Nine other respondents (31%) selected a scale of very important (70 to 90). The next category, 'moderately important', was highlighted by four respondents (13.8%) on a scale of (40 to 60). Finally, seven respondents (24.1%) ranked Variable-D-2 as relatively unimportant (10 to 30).

Variable-D-1-3: To avoid falls (e.g. floor surfaces and lack of handrails)

The following table illustrates the frequency of responses for Variable-D-1-3 *to avoid falls (e.g. floor surfaces and lack of handrails)* on each scale.

Level of importance (%)	Frequency	Percent (%)	Cumulative Percent (%)	Interpretation
10	0	0	0	Relatively unimportant (The least important)
20	1	3.4	3.4	
30	1	3.4	6.9	
40	1	3.4	10.3	Moderately important
50	0	0	0	
60	3	10.3	20.7	
70	4	13.8	34.5	Very important
80	8	27.6	62.1	
90	3	10.3	72.4	
100	8	27.6	100.0	(The most important)
Total	29	100.0		

Table 4.4: Interpretation of the findings for Variable-D-1-3.

As shown in the table, 8 out of 29 respondents emphasised the importance of Variable 3 *(to avoid falls, e.g. floor surfaces and lack of handrails*), by selecting 100 on the sliding scale presented to them (translated into a score of 10 on the working analysis). This latter has been represented by 27.6%, while 15 respondents (51.7%) selected a scale of very important (70 to 90). The next category, 'moderately important', was highlighted by four respondents (13.7%) on a scale of (40 to 60). Finally, two respondents (6.8%) ranked Variable 3 as relatively unimportant (10 to 30).

Variable-D-1-4: Scalability, adaptability and flexibility of the space

The following table illustrates the frequency of responses for Variable-D-1-4 *scalability, adaptability and flexibility of the space* on each scale.

Level of importance (%)	Frequency	Percent (%)	Cumulative Percent (%)	Interpretation
10	0	0	0	Relatively unimportant (The least important)
20	1	3.4	3.4	
30	0	0	0	
40	1	3.4	6.9	Moderately important
50	4	13.8	20.7	
60	0	0	0	
70	5	17.2	37.9	Very important
80	9	31.0	69.0	
90	2	6.9	75.9	
100	7	24.1	100.0	(The most important)
Total	29	100.0		

Table 4.5: Interpretation of the findings for Variable-D-1-4.

As shown in the table, 7 out of 29 respondents emphasised the importance of Variable 4 (*scalability, adaptability and flexibility of the space*), by selecting 100 on the sliding scale presented to them (translated into a score of 10 on the working analysis). This latter has been represented by 24.1% while 16 respondents (55.1%) selected a scale of very important (70 to 90). The next category, 'moderately important', was highlighted by five respondents (17.2%) on a scale of (40 to 60). Finally, one respondent ranked Variable-D-4 as relatively unimportant (10 to 30); this respondent represents only 3.4% of the sample.

Variable-D-1-5: Visual and acoustic privacy

The following table illustrates the frequency of responses for Variable-D-1-5 *Visual and acoustic privacy* on each scale.

Level of importance (%)	Frequency	Percent (%)	Cumulative Percent (%)	Interpretation
10	0	0	0	Relatively unimportant (The least important)
20	0	0	0	
30	1	3.4	3.4	
40	1	3.4	6.9	Moderately important
50	7	24.1	31	
60	2	6.9	37.9	
70	5	17.2	55.2	Very important
80	4	13.8	69	
90	5	17.2	86.2	
100	4	13.8	100.0	(The most important)
Total	29	100.0		

Table 4.6: Interpretation of the findings for Variable-D-1-5.

As shown in the table, 4 out of 29 respondents emphasised the importance of Variable 5 (*visual and acoustic privacy*), by selecting 100 on the sliding scale presented to them (translated into a score of 10 on the working analysis). This latter has been represented by 13.8%; while 14 respondents (48.2%) selected a scale of very important (70 to 90). The next category, 'moderately important', was highlighted by 10 respondents (34.4%) on a scale of (40 to 60). Finally, one respondent (3.4%) ranked Variable-D-5 as relatively unimportant (10 to 30).

Variable-D-1-6: Isolation of rooms and beds

The following table illustrates the frequency of responses for Variable-D-1-6 *Isolation of rooms and beds* on each scale.

Level of importance (%)	Frequency	Percent (%)	Cumulative Percent (%)	Interpretation
10	1	3.4	3.4	Relatively unimportant (The least important)
20	2	6.9	10.3	
30	1	3.4	13.8	
40	2	6.9	20.7	Moderately important
50	5	17.2	37.9	
60	6	20.7	58.6	
70	5	17.2	75.9	Very important
80	1	3.4	79.3	
90	1	3.4	82.8	
100	5	17.2	100.0	(The most important)
Total	29	100.0		

Table 4.7: Interpretation of the findings for Variable-D-1-6.

As shown in the table, 5 out of 29 respondents emphasised the importance of Variable 6 (*isolation of rooms and beds*), by selecting 100 on the sliding scale presented to them (translated into a score of 10 on the working analysis). This latter has been represented by 17.2%, while seven respondents (24%) selected a scale of very important (70 to 90). The next category, 'moderately important', was highlighted by 13 respondents (44.8%) on a scale of (40 to 60). Finally, four respondents (27.5%) ranked Variable-D-6 as relatively unimportant (10 to 30).

Variable-D-1-7: Light and shade

The following table illustrates the frequency of responses for Variable-D-1-7 *Light and shade* on each scale.

Level of importance (%)	Frequency	Percent (%)	Cumulative Percent (%)	Interpretation
10	1	3.4	3.4	Relatively unimportant (The least important)
20	1	3.4	6.9	
30	1	3.4	10.3	
40	1	3.4	13.8	Moderately important
50	5	17.2	31.0	
60	1	3.4	34.5	
70	4	13.8	48.3	Very important
80	8	27.6	75.9	
90	1	3.4	79.3	
100	6	20.7	100.0	(The most important)
Total	29	100.0		

Table 4.8: Interpretation of the findings for Variable-D-1-7.

As shown in the table, 6 out of 29 respondents emphasised the importance of Variable 7 (*light and shade*), by selecting 100 on the sliding scale presented to them (translated into a score of 10 on the working analysis). This latter has been represented by 20.7%; while 13 respondents (44.8%) selected a scale of very important (70 to 90). The next category, 'moderately important', was highlighted by seven respondents (24%) on a scale of (40 to 60). Finally, three respondents (10.2%) ranked Variable-D-7 as relatively unimportant (10 to 30).

Variable-D-1-8: Colour used in the space

The following table illustrates the frequency of responses for Variable-D-1-8 *colour used in the space* on each scale.

Level of importance (%)	Frequency	Percent (%)	Cumulative Percent (%)	Interpretation
10	0	0	0	Relatively unimportant (The least important)
20	2	6.9	6.9	
30	2	6.9	13.8	
40	1	3.4	17.2	Moderately important
50	7	24.1	41.4	
60	5	17.2	58.6	
70	4	13.8	72.4	Very important
80	5	17.2	89.7	
90	1	3.4	93.1	
100	2	6.9	100.0	(The most important)
Total	29	100.0		

Table 4.9: Interpretation of the findings for Variable-D-1-8.

As shown in the table, 2 out of 29 respondents emphasised the importance of Variable 8 (*colour used in the space*), by selecting 100 on the sliding scale presented to them (translated into a score of 10 on the working analysis). This latter has been represented by 6.9%, while 10 respondents (34.4%) selected a scale of very important (70 to 90). The next category, 'moderately important', was highlighted by 13 respondents (44.7%) on a scale of (40 to 60). Finally, four respondents (13.8%) ranked Variable-D-8 as relatively unimportant (10 to 30).

Variable-D-1-9: Daylight and artificial light

The following table illustrates the frequency of responses for Variable-D-1-9 *Daylight and artificial light* on each scale.

Level of importance (%)	Frequency	Percent (%)	Cumulative Percent (%)	Interpretation
10	0	0	0	Relatively unimportant (The least important)
20	0	0	0	
30	0	0	0	
40	0	0	0	Moderately important
50	2	6.9	6.9	
60	2	6.9	13.8	
70	1	3.4	17.2	Very important
80	11	37.9	55.2	
90	4	13.8	69.0	
100	9	31.0	100.0	(The most important)
Total	29	100.0		

Table 4.10: Interpretation of the findings for Variable-D-1-9.

As shown in the table, 9 out of 29 respondents emphasised the importance of Variable 9 (*daylight and artificial light*), by selecting 100 on the sliding scale presented to them (translated into a score of 10 on the working analysis). This latter has been represented by 37.9%; while 16 respondents (55.1%) selected a scale of very important (70 to 90). The next category, 'moderately important', was highlighted by 4 respondents (13.8%) on a scale of (40 to 60). No respondent ranked Variable-D-9 as relatively unimportant (10 to 30).

Variable-D-1-10: Air quality

The following table illustrates the frequency of responses for Variable-D-1-10 *Air quality* on each scale.

Level of importance (%)	Frequency	Percent (%)	Cumulative Percent (%)	Interpretation
10	1	3.4	3.4	Relatively unimportant (The least important)
20	0	0	0	
30	0	0	0	
40	0	0	0	Moderately important
50	3	10.3	13.8	
60	1	3.4	17.2	
70	1	3.4	20.7	Very important
80	11	37.9	58.6	
90	5	17.2	75.9	
100	7	24.1	100.0	(The most important)
Total	29	100.0		

Table 4.11: Interpretation of the findings for Variable-D-1-10.

As shown in the table, 7 out of 29 respondents emphasised the importance of Variable 10 (*Air quality*), by selecting 100 on the sliding scale presented to them (translated into a score of 10 on the working analysis). This latter has been represented by 24.1%; while 17 respondents (58.5%) selected a scale of very important (70 to 90). The next category, 'moderately important', was highlighted by four respondents (13.7%) on a scale of (40 to 60). Finally, one respondent ranked Variable-D-10 as relatively unimportant (10 to 30); this respondent represents only 3.4% of the sample.

Variable-D-1-11: Noise

The following table illustrates the frequency of responses for Variable-D-1-11 *Noise* on each scale.

Level of importance (%)	Frequency	Percent (%)	Cumulative Percent (%)	Interpretation
10	1	3.4	3.4	Relatively unimportant (The least important)
20	0	0	0	
30	0	0	0	
40	2	6.9	10.3	Moderately important
50	2	6.9	17.2	
60	2	6.9	24.1	
70	2	6.9	31.0	Very important
80	4	13.8	44.8	
90	11	37.9	82.8	
100	5	17.2	100.0	(The most important)
Total	29	100.0		

Table 4.12: Interpretation of the findings for Variable-D-1-11.

As shown in the table, 5 out of 29 respondents emphasised the importance of Variable 11 (*Noise*), by selecting 100 on the sliding scale presented to them (translated into a score of 10 on the working analysis). This latter has been represented by 17.2%; while 17 respondents (58.6%) selected a scale of very important (70 to 90). The next category, 'moderately important', was highlighted by six respondents (20.7%) on a scale of (40 to 60). Finally, one respondent ranked Variable-D-11 as relatively unimportant (10 to 30); this respondent represents only 3.4% of the sample.

Variable-D-1-12: Furniture placement

The following table illustrates the frequency of responses for Variable-D-1-12 *Furniture placement* on each scale.

Level of importance (%)	Frequency	Percent (%)	Cumulative Percent (%)	Interpretation
10	1	3.4	3.4	Relatively unimportant
20	0	0	0	(The least important)
30	3	10.3	13.8	
40	1	3.4	17.2	Moderately important
50	2	6.9	24.1	
60	5	17.2	41.4	
70	5	17.2	58.6	
80	6	20.7	79.3	Very important
90	3	10.3	89.7	
100	3	10.3	100.0	(The most important)
Total	29	100.0		

Table 4.13: Interpretation of the findings for Variable-D-1-12.

As shown in the table, 3 out of 29 respondents emphasised the importance of Variable 12 (*Furniture placement*), by selecting 100 on the sliding scale presented to them (translated into a score of 10 on the working analysis). This latter has been represented by 10.3%; while 14 respondents (48.2%) selected a scale of very important (70 to 90). The next category, 'moderately important', was highlighted by 8 respondents (27.5%) on a scale of (40 to 60). Finally, four respondents (13.7%) ranked Variable-D-12 as relatively unimportant (10 to 30).

The central tendency measurement of Variables

The table below illustrates the measurement of the tendency for each variable that helps in identifying the most critical issue "Variable" (e.g. Var-D-1-1, Var-D-1-2, etc.) among the issues above (Variables). The table explores the mean and the standard deviation (st.dev), for each variable.

	Variables											
	Var-D-1-1	*Var-D-1-2*	*Var-D-1-3*	*Var-D-1-4*	*Var-D-1-5*	*Var-D-1-6*	*Var-D-1-7*	*Var-D-1-8*	*Var-D-1-9*	*Var-D-1-10*	*Var-D-1-11*	*Var-D-1-12*
Mean	8.4483	6.7931	7.7931	7.6207	7.1034	6.1724	6.9655	6.0690	8.3793	8.00	7.7931	6.6897
Std. Dev	2.09738	3.24455	2.12770	2.06006	2.02387	2.50811	2.48543	2.12016	1.49795	2.01778	2.22613	2.30067

Table 4.14: The central tendencies of Designers 'Variables.

According to the results displayed in the table, **Variable D-1-1** "*to avoid hospital-acquired infections*" shows the biggest mean in the data set 8.4483 that corresponds to 84.483 (referring to the original scale 10 to 100) and a low standard deviation 2.09738 that corresponds to 20.9738 (original scale). This indicates that data is very closely related to the average; hence, in this case the mean is a reliable indicator of the level of importance. In other words, the first variable is considered the most important among all other variables according to the mean and standard deviation. The next most crucial issue (**Variable D-1-9**) is *Daylight and artificial light* with a mean of 8.3793 (83.793) and a standard deviation of 1.49795 (14.9795) followed by *Air quality* **Variable D-1-10** whose mean and standard deviation are 8.00 and 2.01778, respectively. The fourth important issue (**Variable D-1-3**) is *To avoid falls* with a mean of 7.7931 and a standard deviation of 2.12770.

The fifth most important issue (**Variable D-1-11**) is *Noise* with a mean and standard deviation of 7.7931 and 2.22613, respectively. The sixth important issue (**Variable D-1-4**) is *Scalability, adaptability and flexibility of the space* with a mean and standard deviation of 7.6207, 2.06006 (20.06006) respectively. The seventh issue (**Variable D-1-5**) is *Visual and acoustic privacy* with a mean of 7.1034 and standard deviation of, 2.02387. The eighth issue is **Variable D-1-7** *Light and shade* with a mean and standard deviation of 6.9655, 2.48543 respectively. The ninth issue (**Variable D-1-2**) is *To avoid medication errors* with a mean and standard deviation of 6.7931, 3.24455 (32.445) respectively. The tenth issue (**Variable D-1-12**) is *Furniture placement* with a mean of 6.6897 and standard deviation of 2.30067. Last, the eleventh important issue (**Variable D-1-6**) is *Isolation of rooms and beds* with a mean and standard deviation of 6.1724, 2.50811 respectively. Finally, the twelfth issue (**Variable D-1-8**) is *Colour used in the space* with a mean and standard deviation of 6.0690, 2.12016 respectively.

From the descriptive analysis, all issues are regarded as being of some importance in the design of hospital wards but were ranked by respondents in order of their priority. Designers believe that the most critical issue is to avoid infections in the design of hospitals. Their second concern is the daylight and artificial light, as providing a space with good lighting is important for staff and patients. Also, the air quality is an essential factor in the design of hospital wards, as space should have good air quality (this can help in minimising the infections in the ward). Designers also pay attention to the details in the room such as the flooring type, bed rails in order to minimise the rate of falls for patients and staff. To reduce noise (e.g. by effective sound insulation of the space) is classified as the fifth most crucial issue designers deal with. The flexibility of the space and its adaptability is ranked sixth amongst the 12 issues, followed by the visual and acoustic privacy that help in minimising the noise in the ward. The remaining five issues are essential as well but not as much as the first ones. These are 'light and shade', 'to avoid medication errors', 'furniture placement', 'isolation of rooms and bed's and 'colour used in the space'. These responses were taken forward for subsequent discussion and validation in the interview of designers that followed. They also informed the design of the healthcare users' survey.

Following question one, participants were asked if there were other important issues additional to the ones mentioned above. Designers emphasised the importance of infection control, one of the respondents claimed that "Whilst all areas are important requirements for the design of a room that is easy and safe to use as well as fostering well-being from both the hospital staff and patients' perspective the priority is always infection control" Designer 1. Although in the section where further comments were invited, another respondent mentioned that it is purely a management issue rather than a design issue. Another respondent noted that "There is no point in admitting a patient to hospital if they are going to pick up another infection, which compromises their existing condition and may kill them. All of the other issues contribute to the successful avoidance of secondary infection. Burt [sic] most of all clinicians and visitors should WASH their hands so make sure the washbasin is prominent and not used for other purposes" Designer 14. Four respondents out of 29 respondents claimed that all issues are equally important in the design of a patient room. Some of their thoughts are presented as follows "This is an odd question and difficult to answer, as all of the criteria are important and I do not think it is an either / or consideration between factors" Designer 2.

> "All of the issues are equally important and a design has to balance all of these things within guidelines, costs, time to meet the demographic [sic] of the patient and staff groups" (Designer 15).
>
> "All of the issues are 100% important" (Designer 16)
>
> "many of the above are equally important, and in most cases, one comes as a consequence of another, such as single bed bays provide acoustic and visual privacy and isolation to reduce infection risks" (Designer 20).

Regarding the second issue to avoid medication errors, one of the respondents claimed that this is a management issue, "The use and control of drugs is largely a management issue" Designer 5. One respondent claimed that the issue of avoiding falls is not in control of architects or depends mainly on the design because of moving the furniture "we are unpersuaded that the design can overcome all the issues of falls because the furniture is often moved about [sic] the room" Designer 12. In terms of the scalability, adaptability and flexibility of the space, two respondents claimed that are important factors in the design, "creating a healing environment for patients and a stimulating and work-friendly environment for staff are the key aims of designing a hospital ward space. Ergonomically designed flexible spaces are key together with good daylight" Designer 4, "efficiency of space and ergonometric design for staff benefit is critical" Designer 10. The visual and acoustic privacy could be achieved by designing single bed bays as one of the respondents stated "single bed bays provide acoustic and visual privacy" Designer 20. The issue of isolating rooms are for different purposes, according to designers, it could be because of the immunosuppressed patients as one respondent stated that "Isolation of rooms and beds-only for immunosuppressed patients and end of life care" Designer 23. One respondent claimed that some patients recover quicker when are alone in the single beds as claimed "Isolation of bedrooms is important only when clinically required; otherwise we get user feedback of patients being able to socialise outside their private bedroom in a communal space" Designer 3. One of the respondents claimed that the isolation of beds and rooms could be different depending on situations "to individualise them seems too black and white" Designer 20. Other patients may recover quicker when communicating with others in multi- bed bays as stated by one of the designers "As for Isolation, there have been changes in the trends for this. I worked on the Queen Elisabeth Memorial Hospital for four years finishing in 2012; at this time, the trend was for separate beds to stop infection. Now this has changed as people get better quicker when they are in wards with multiple patients" Designer 28.

Another one stated that “we design almost exclusively 100% single rooms and in so doing address many of the issues you raise” Designer 12. Three respondents claimed that the design of multi-bed bays is important, and could be the requirement of the client “some of these issues may be associated with patient preferences, i.e. single rooms are suitable for some but may be [sic] lonely for others” Designer 5. In addition to patient preferences “not all apply to every healthcare facility e.g. in a renal facility multi chair rooms are preferred for patient social interaction and observation over individual rooms” Designer 16. The design of wards should be done by mixing single bed bays that help in speeding the process of recovery “the use of all single bedrooms doesn't always present the best healing environment. Some patients require the company of others. A mix of single and multi-bed rooms is now perceived to be a better arrangement” Designer 4. The other issues that are light and shade, colour used in the space, daylight and artificial light, air quality, noise and placement of furniture were claimed respectively, “the most important is the wellness of the patients. Lighting, comfort, air quality all play a part in this” Designer 28; “ergonomically designed flexible spaces are key together with good daylight and aspect. Good sound attenuation and management of solar gain are glare are important to both staff and patients” Designer 4; “Placement of clinical furniture such as the bed is more critical than, for example, a visitor’s chair” Designer 16.

In addition to other important issues that include the efficient and effective workflow, as stated by one of the respondents “other equally important factors are effective and efficient workflow, a therapeutic environment with access to views, ease of wayfinding, and excellent observation” Designer 2. One respondent noted “location of en-suite to single bedrooms are a big part of the design and how the design of the ward impacts the layout and footprint of the ward” Designer 9. Moreover, the quality of the furniture tends to be critical for architects as stated by one of the respondents “the biggest challenge we face is the poor quality of almost every item of furniture which the NHS use - bins, chairs, lockers etc. They are really poor and uncoordinated unless you spend a great deal of time and effort - for which we do not get paid” Designer 12. He has also mentioned that “in a Design and Build our ability as architects to exert any control on design quality and MEP coordination.” Another issue was pointed out by one respondent, which is the views “views out / visual connection with outside and greenery” Designer 13. In addition to the privacy factor that plays against the observation side and is contradictory most of the time as stated by one respondent “Privacy and observation generally play off against each other, as they're somewhat contradictory.

Different organisations (and to some extent different medical specialism) will prioritise the two things differently" Designer 17. One respondent pointed out that the comfort of patients and their visitors are primordial by having control on their environment "we often find patients and visitors having control of their environment is important, i.e. opening windows, blinds, controllable natural ventilation enhances their comfort" Designer 19. Space availability and fire strategy are other issues that should be briefed before space being planned as two respondents said "private rooms are limited by budget and available space" Designer 24; "IT infrastructure also adds an additional requirement for space which is often not briefed until after a space has been planned. Fire strategy is often an issue which determines planning" Designer 20.

Designers/architects need to design the ward according to the health technical memoranda "HTMs", and the health building notes "HBNs" and contemporary guidelines. This issue was claimed by one respondent "the design of a patient room should be designed in line with contemporary design guidance (HTM/HBN), as well as understanding specific requirements from users as to any variant functional requirement of spaces" Designer 26. Another important factor in the design is the visibility from nursing staff station to the patient room as claimed by one respondent "visibility from nursing staff into patient room" Designer 21. Another issue is the adjacency of spaces to the related activities "efficiency of space and ergonometric design for staff benefit is critical. Adjacency to related activities/spaces is critical" Designer 10. Finally, designers agree that space should be ergonomically designed and balanced by taking in consideration all the previous criteria, by providing good air quality, lighting and comfort within the guidelines, the budget and time.

Question 2: To what extent do you use the following in designing a hospital ward?

The second question investigates the importance of design methodology in hospital wards, as shown in the figure below. The respondents are required to rank the design methodologies retrieved from the literature review (Hackbarth and Grover 1999, Bose 2003, Steiner 2006, Niedderer 2007, Bessant and Maher 2009, Whitbread 2009, Kothari et al. 2012, Li and Zhang 2013, Phiri 2014, Khambete et al. 2015, Falbo et al. 2016). The ranking should be done by selecting 10 to 100 on the sliding scale from the least important to the most important presented to them (translated into a score of 1 to 10 on the working analysis).

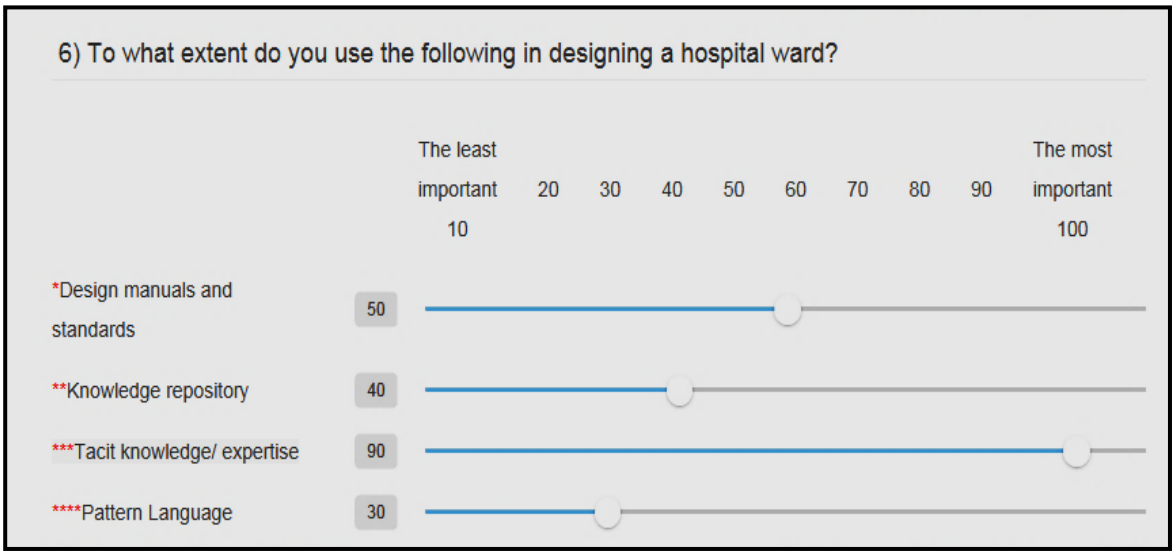

Figure 4.3: Screenshot of the second question in the survey.

The table below represents the data retrieved from the respondents according to each variable.

		Design manuals and standards	Knowledge repository	Tacit knowledge/expertise	Pattern language
N	Valid	29	29	29	29
	Missing	0			

Table 4.15: Sample size presented in the table with the variables.

The statistics table displays the sample size for the following Variables:

- ***Design manuals and standards,***
- ***Knowledge repository,***
- ***Tacit knowledge/expertise*** and
- ***Pattern language***.

There were 29 valid observations for all variables. There were no missing values for any of the variables. The following section will discuss the frequencies for each Variable for the second question.

Variable-D-2-1: Design manuals and standards

The following table illustrates the frequency of responses for Variable-D-2-1 *Design manuals and standards* on each scale.

Level of importance	Frequency	Percent (%)	Cumulative Percent (%)	Interpretation
10	0	0	0	Relatively unimportant
20	0	0	0	(The least important)
30	0	0	0	
40	2	6.9	6.9	
50	1	3.4	10.3	Moderately important
60	1	3.4	13.8	
70	2	6.9	20.7	
80	3	10.3	31.0	Very important
90	9	31.0	62.1	
100	11	37.9	100.0	(The most important)
Total	29	100.0		

Table 4.16: Interpretation of the findings for Variable-D-2-1.

The same analysis procedure has been used in this question, as respondents have been required to rank at intervals of 10; therefore, the level of importance between Variables (4 design methodologies) is shown as 10, 20, and 30 until 100, which is referred to it as the "importance index". Although it was asked to select from the least important (10) to the most important (100), however in the analysis, each three intervals have been grouped according to their level of importance; as in from 10 to 30 labelled as relatively unimportant (the least important), from 40 to 60 is labelled as moderately important. From 70 to 90 is labelled as very important and finally, 100 labelled as the most important as illustrated in the interpretation column in the figure above. As shown in the table above, 11 out of 29 respondents emphasised the importance of Variable 1 (*to avoid hospital-acquired infections*) by selecting 100 on the sliding scale presented to them (translated into a score of 10 on the working analysis) represented by 37.9%; while 14 respondents (48.2%) selected a scale of very important (70 to 90). The next category, 'moderately important', was highlighted by 4 respondents (13.7%) on a scale of (40 to 60). Finally, no response was shown as relatively unimportant (10 to 30).

Variable-D-2-2: Knowledge repository

The following table illustrates the frequency of responses for Variable-D-2-2 *Knowledge repository* on each scale.

Level of importance	Frequency	Percent (%)	Cumulative Percent (%)	Interpretation
10	2	6.9	6.9	Relatively unimportant
20	1	3.4	10.3	(The least important)
30	0	0	0	
40	0	0	0	
50	3	10.3	20.7	Moderately important
60	2	6.9	27.6	
70	4	13.8	41.4	
80	8	27.6	69.0	Very important
90	3	10.3	79.3	
100	6	20.7	100.0	(The most important)
Total	29	100.0		

Table 4.17: Interpretation of the findings for Variable-D-2-2.

As shown in the table, 6 out of 29 respondents emphasised the importance of Variable 2 (*Knowledge repository*) by selecting 100 on the sliding scale presented to them (translated into a score of 10 on the working analysis) represented by 20.7%; while 15 respondents (51.7%) selected a scale of very important (70 to 90). The next category, 'moderately important', was highlighted by 5 respondents (17.2%) on a scale of (40 to 60). Finally, three respondents (10.3%) ranked Variable-D-2-2 as relatively unimportant (10 to 30).

Variable-D-2-3: Tacit knowledge/expertise

The following table illustrates the frequency of responses for Variable-D-2-3 *Tacit knowledge/expertise* on each scale.

Level of importance	Frequency	Percent (%)	Cumulative Percent (%)	Interpretation
10	0	0	0	Relatively unimportant
20	0	0	0	(The least important)
30	0	0	0	
40	0	0	0	
50	2	6.9	6.9	Moderately important
60	1	3.4	10.3	
70	2	6.9	17.2	
80	4	13.8	31.0	Very important
90	4	13.8	44.8	
100	16	55.2	100.0	(The most important)
Total	29	100.0		

Table 4.18: Interpretation of the findings for Variable-D-2-3.

As shown in the table, 16 out of 29 respondents emphasised the importance of Variable 3 (*Tacit knowledge/expertise*) by selecting 100 on the sliding scale presented to them (translated into a score of 10 on the working analysis) represented by 55.2%; while 10 respondents (34.5%) selected a scale of very important (70 to 90). The next category, 'moderately important', was highlighted by 3 respondents (17.2%) on a scale of (40 to 60). Finally, 3 respondents (10.3%) ranked Variable-D-2-3 as relatively unimportant (10 to 30).

Variable-D-2-4: Pattern language

The following table illustrates the frequency of responses for Variable-D-2-4 *Pattern language* on each scale.

Level of importance	Frequency	Percent (%)	Cumulative Percent (%)	Interpretation
10	6	20.7	20.7	Relatively unimportant
20	3	10.3	31.0	(The least important)
30	2	6.9	37.9	
40	2	6.9	44.8	
50	5	17.2	62.1	Moderately important
60	4	13.8	75.9	
70	1	3.4	79.3	
80	3	10.3	89.7	Very important
90	2	6.9	96.6	
100	1	3.4	100.0	(The most important)
Total	29	100.0		

Table 4.19: Interpretation of the findings for Variable-D-2-4.

As shown in the table, 1 out of 29 respondents emphasised the importance of Variable 4 (*Pattern language*) by selecting 100 on the sliding scale presented to them (translated into a score of 10 on the working analysis) represented by 3.4%; while 6 respondents (20.6%) selected a scale of very important (70 to 90). The next category, 'moderately important', was highlighted by 11 respondents (37.9%) on a scale of (40 to 60). Finally, 11 respondents (37.9%) ranked Variable-D-2-4 as relatively unimportant (10 to 30).

The central tendency measurement of Variables

The table below illustrates the measurement of the tendency for each variable that helps in identifying the most important design methodology "Variable" (e.g.Var-D-2-1, Var-D-2-2, etc.) among the aforementioned Variables. The table explores the mean and standard deviation (st.dev) for each variable.

	Variables			
	Var-D-2-1	*Var-D-2-2*	*Var-D-2-3*	*Var-D-2-4*
Mean	8.5517	7.2414	8.8966	4.6207
Std. Dev	1.80448	2.55867	1.56627	2.80833

Table 4.20: The central tendencies of Designers 'Variables.

According to the results displayed in the table, **Variable-D-2-3** "*tacit knowledge /expertise*" shows the biggest mean in the data set 8.8966 that corresponds to 88.966 with a low standard deviation 1.56627 (15.6627) which indicates that the data is very closely related to the average, hence a low variance between the data and the statistical average, thus reliable. In other words, the third variable "tacit knowledge /expertise" is considered to be the most important among all other Variables according to the mean and standard deviation. According to the measures of tendency, the next important design methodology is **Variable-D-2-1** design manuals and standards, with a mean 8.5517 and a standard deviation 1.80448, followed by **Variable-D-2-2** knowledge repository whose mean and standard deviation is 7.2414 and 2.55867 respectively.

Finally, the least important design methodology is **Variable-D-2-4** pattern language with a mean and standard deviation of 4.6207 and 2.80833, respectively. Tacit knowledge or expertise has been identified as the most important methodology in the design, as architects use their knowledge first before any design then refer to the design manuals and standards, followed by knowledge repository, which is used as a design reference tool. Pattern language has not been highly chosen because of the unfamiliarity of designers with the term. This question can be validated in the interviews that follow.

Question 3: If your company uses BIM, does your use of BIM depend upon?

- a- size of projects
- b- type of clients
- c-type of project or client (e.g. because it is required by the client or the lead contractor)

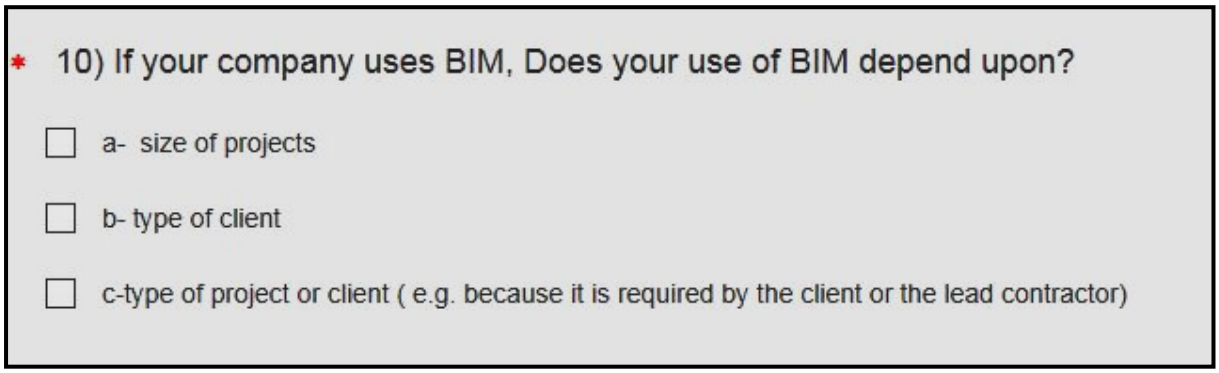

Figure 4.4: Screenshot of the third question in the survey.

The third question investigates the factors that BIM depends upon in the design of hospital wards, and more accurately, the use of BIM by architects. In Chapter 2, it was proposed that the use of BIM might enable designs to be standardised more and for standard 'objects' (and their parameters) to be imported into a design, which makes design decisions automatic, therefore the purpose of the third question. The respondents were required to select among three options in case their company uses BIM. The options are size of projects, type of client and type of project or client (because the client or the lead contractor require it).

	Size of projects	Type of clients	Type of project or client (e.g. because it is required by the client or the lead contractor)
Valid	29	29	29
Missing		0	

Table 4.21: Sample size presented in the table with the variables.

The statistics table displays the sample size for the following variables:

- ***Size of projects*****,**
- ***Type of clients*****,** and
- ***Type of project or client (e.g. because it is required by the client or the contractor lead).***

The table above indicates that there were 29 valid observations for all variables. There were no missing values for any of the variables.

Variable-D-3-1: Size of projects

The following table illustrates the frequency of responses for Variable-D-3-1 *Size of projects* on each scale.

		Frequency	Percent	Cumulative Percent
Valid	No	13	44.8	44.8
	Yes	16	55.2	100.0
	Total	29	100.0	

Table 4.22: Interpretation of the findings for Variable-D-3-1.

The frequencies for Variable-D-3-1 (*Size of projects*) are displayed in the table above. In the table, 16 out of 29 respondents (55.2%) emphasised the importance of size of projects while using BIM, while 13 respondents (44.8%) rejected this option while using BIM.

Variable-D-3-2: Type of clients

The following table illustrates the frequency of responses for Variable-D-3-2 *Type of clients* on each scale.

		Frequency	Percent	Cumulative Percent
Valid	No	17	58.6	58.6
	Yes	12	41.4	100.0
	Total	29	100.0	

Table 4.23: Interpretation of the findings for Variable-D-3-2.

The frequencies for Variable-D-3-2 (*Type of clients*) is displayed in the table above. In the table, 12 out of 29 respondents (41.4%) emphasised the importance of 'type of clients' while using BIM, while 17 respondents (58.6%) rejected this option while using BIM.

Variable-D-3-3: Type of project or client (e.g. because it is required by the client or the lead contractor)

The following table illustrates the frequency of responses for Variable-D-3-3 *Type of project or client (e.g. because it is required by the client or the lead contractor)* on each scale.

		Frequency	Percent	Cumulative Percent
Valid	No	9	31.0	31.0
	Yes	20	69.0	100.0
	Total	29	100.0	

Table 4.24: Interpretation of the findings for Variable-D-3-3.

The frequencies for Variable-D-3-3 (*Type of project or client (e.g. because it is required by the client or the lead contractor)* is displayed in the table above. In the table, 20 people out of 29 respondents (69%) emphasised the importance of type of project or client (e.g. because it is required by the client or the lead contractor) while using BIM, while only 9 respondents (31%) rejected this option while using BIM.

The central tendency measurement of Variables

The table below illustrates the measurement of the tendency for each variable that helps in identifying the most important option (Variable) among the aforementioned Variables. The table explores the mean and the standard deviation (st.dev) for each variable.

	Variables		
	Var-D-3-1	*Var-D-3-2*	*Var-D-3-3*
Mean	.5517	.4138	.6897
Std. Dev	.50612	.50123	.47082

Table 4.25: The central tendencies of Designers 'Variables.

According to the results displayed in the table, **Variable-D-3-3** "*Type of project or client (e.g. because it is required by the client or the lead contractor*)", is the option with the biggest mean in the data set (0.6897). The low standard deviation of 0.47082 indicates that data are very closely related to the mean, which can thus be taken as reliable. In other words, **Variable-D-3-3** "*Type of project or client (e.g. because it is required by the client or the lead contractor*)" is considered to be the most important among all the other variables according to the mean and standard deviation. The next most important criterion was **Variable-D-3-1 "***Size of projects"*. This shows a mean of 0.5517 and a standard deviation of 0.50612. The third option **Variable-D-3-2 "***Type of clients"* was considered the least important with a mean and standard deviation of 0.4138 and 0.50123 respectively.

However, 18 participants have selected all three options in the optional comment box and also explained in the box below that they use BIM in their company irrespective of the type of client or size of projects or requirements, and that BIM is mandatory in their design process as stated

> "we use BIM on every project regardless of size or client" (Designer 23).
>
> "all options, with 90% of our proejcts [sic] carried out using BIM" (Designer 19).
>
> "use of BIM is our default, the extent to which we encode data is driven by individual project requirements" (Designer 17).

Another respondent claimed that "All our projects have an element of BIM- not necessarily to BIM Standard Protocols, but producing door/equipment schedules directly from our model does this even if the client does not want to receive [sic] Cobie drops" Designer 17. One respondent stated that "the use of BIM depends on the expertise fo the design team" Designer 20.

4.1.2 THEMATIC ANALYSIS OF THE OPEN-ENDED SURVE QUESTIONS

In this section, the seven open-ended questions (shown in the Appendix 1) were analysed. Thematic analysis has been conducted on the keywords in the responses to these questions. A list of keyword responses to each of the seven questions is shown in Table 4.26. The codes that emerged are shown in Table 4.27 alongside their main and sub-themes. The software that has been used to structure and analyse the responses of the survey is NVivo "https://www.qsrinternational.com/nvivo-qualitative-data-analysis-software/home".

The responses of participants were structured in NVivo, which helped in highlighting the relevant keywords according to each question. The main themes were identified according to the type of question and responses and then codes and sub-themes were extracted from the keywords.

Question 1	Question 2	Question 3	Question 4	Question 5 A	Question 5 B	Question 6	Question 7
• Room layout • Accessibility • Circulation around patient • Observation • Patient Privacy • Patient dignity • Clinical functionality • Workflow • Patient' safety • Patient and visitor quality environment • Prevention of Falls • Sightline to bed • Single rooms effects +/- • Insufficient storage • Noise • Infection control • Slip resistance • Visibility • Location of en-suite • Relationship of en-suite to bedrooms • Temperature • Odour • Lack of observation • Working spaces • Patient spaces • Dirt • Bad planning of space • Furniture placement • Cost • Taps • Electrical points • Blinds • HBNs and HTMs compliance • Fire strategy • Same gender accommodation • Lack of showers in rooms • Daylight • Air quality • Final finishes • Interior design • Modern technologies • Light • Medication errors • Family zone rooms • Signage	• Observation • Privacy • Type of materials • Infection control • Single rooms • Nursing workflow • Access to daylight • Access to views • Variety of interior design • Slip resistance • flooring type • Cleaning materials • Patient flow • Care pathways • Care type (Acute care to Primary care Social care) • Funding and spending • User engagement • awareness of clinicians of waste disposal • Theatre requirement • Flexibility of space • Loose furniture placement • Light • Colour • patient visibility • safety • circulation spaces • achieving optimal adjacencies • Discrete installation of building services • Temperature • Room layout • observation • views out • location of en-suite • Cost issues • Floor space required • Noise • Funding • Storage space • Meeting client expectations • Daylight • Adaptable and flexible room layout design • Finishes • Compliance with HTMs • good design • Lack of space • Designing a set space • Room area for good environment • Bathrooms & showers • HVAC • Corridors • Ventilation • Ceiling heating	• Room layout • Equipment use • Ward relationships organisation • patient observation • layout repetition • Clinical Brief establishment • End user engagement • Design response • Visual and acoustic privacy • Patient observation • Visibility of staff • Daylight • Views • Access to natural light • Colour palettes • Furniture placement • Stakeholders engagement • Technical delivery • knowledge of current guidance and legislation • safe environment • best practice layouts • space planning • ward planning • Adaptable and flexible room layout design • Infection control measures • interior design • specification for finishes • up to date HC trends • staff retention • patient focus • spatial and statutory requirements • Bedroom model (inboard, outboard or nested model) • Observation • touchdown bases • falls protection • colours • finishes • interior finishes • realistic operational matters • layouts • air quality	• entrenched opinions • mechanical ventilation • En-suite layout • Excessive opinions • Infection control • Different views on room layout • En-suite level of accessibility • Size • Observation • Accessibility • Daylight • Number and type of outlets • Higher standards requirements • Cost increase • Inflexibility of staff of modern design • HBN compliance • User choice in design • Good outlook from the rooms • IT infrastructure • Lack of staff facilities • Lack of storage • Reduced sizes • Agreement of all stakeholders • Room layout • Placement of furniture • Placement of electrical points • Design follow up • Continual engagement • Review and approval process • Management of local requirements • National standards • compliance	• HTMs • HBNs • Statutory documents • Models of care • Adjacency matrix • Room data sheets • Good practice knowledge • Space requirements • Observation • Clinical functionality • Environment staff • Planning • Clinical ratios • M&E requirements • Spatial arrangements • Client requirements • Coordination of building design • Service and structure elements • Sightline • Reduced travel distances to Med and supplies • Flexibility • Staff familiarisation • Buildability • Ease of maintenance • The clinical process • Spatial requirements/movements • Technical requirements of specialist equipment • Daylight • Views • Storage space • staff movement • supplies • rapid access • patient and staff demography • Number of single beds • Number of bed bays • Types of rooms • Isolation and ensuite requirements • nursing/staffing ratios • adjacencies to other departments • engineering • positive/negative pressure regimes • isolation facilities • number of sanitary facilities • dirty utilities • ventilation • functionality • security	• Observation • Equipment • Ventilation • Accessibility • level of nursing • isolation • infection control • Equipment • staff ratios • space requirements • air filtration • access to outdoors • larger rooms • central bed location • use of pendants for services • access to a therapy space • twin rooms • humidity control • proximity to theatres • size of rooms • routes from and to • telemetry • daylight • space • views • FF&E fitting furniture and equipment • integration of services • maintenance	• Personal and colleagues' experience • HBNs • HTMs • basic compliance • derogations • briefing • client requirements • Leed (leadership in energy and environmental design) criteria • Knowledge • POE • research studies • benchmarking • patient and staff feedback • study tours • desk-top studies(research) • British standards • Approved Building Regulations documents • Knowledge sharing • best practice • evidence based design research • P22 repeatable room data • recent project experience • user consultation • digital libraries • tacit knowledge • expertise • pattern language • Peer reviews • Architectural journals • visits to new facilities • ADB standard rooms • equipment lists • Statutory regulations • case studies • Clinical Care Standards • BS8300 British Standards 8300 • DoH • BIM models • Client Schedules of Accommodation • Hospital facilities and strategic planning groups • user groups, trends • FGI The Facility Guidelines Institute • P21 example rooms • DIMH forums Design in Mental Health • HIS Healthcare Infection Society	• Recent case studies • Understanding of users of design, limitations and budget • POE • Recovery rate • Schedule of accommodation and space standards • Old HBN diagrams • Feedback • EBD libraries • User interactions • Consistent briefing • Best practice • Global POE library

Table 4.26: keywords arising from the open-ended questions.

Main Theme	Sub-Themes	Codes
1. Design Matters	**1.1** Clinical good practice	• Control of infection • General care • Special care • Transfer between clinical units • Room Layout • Flexibility and adaptability
	1.2 Patient comfort and safety	• Personal needs • Disabilities • Emotional: privacy, aesthetic, dignity • Cultural needs • Security
	1.3 Staff (comfort and safety issues)	• Security • Productivity: clinical spaces, sightline, observation, walking distances • Ergonomics: movement, transfers, movement of equipment
	1.4 Cost	• Capital • Maintenance by FM • Operating cost
2. Design Guidance	**2.1** Codes and practice notes	• Best practices • LEED criteria • BS8300 • DoH 'Department of Health' • ADB standard rooms • Building regulations • HTMs • HBNs • Statutory regulations
	2.2 Specifications	• Understanding of user of budget • Briefing • Client requirements
	2.3 Experiential feedback	• Personal experience • Case studies • Post Occupancy Evaluation 'POE' • Case studies

Table 4.27: Main Themes with Sub-Themes and their codes.

The following section takes each question at a time and subjects the responses to the thematic analysis as described above in Table 4.27. Throughout the analysis, some of the questions happened to have only one theme and few sub-themes.

4.1.2.1 Q.1) Which issue (s) do you get most user feedback on?

In this question, two themes **'Design Matters'** and **'Design Guidance'** have been identified and discussed in the responses of the participants. Of the twenty-nine respondents, twenty-five responded fully where codes and sub-themes were retrieved. Surprisingly, three designers stated that there was no issue as shown in their responses. "*No issues, very few*" (Designer 12, 25 and 28) or that they did not need feedback "*Having worked solely in healthcare for a number of years we have good standard procedures for designing these types of rooms."* (Designer 18)

The first sub-theme ***'clinical good practice'*** was addressed by many respondents indicating that this is one of the most important issues designers get feedback on. Among the responses, the following codes have been identified: '*accessibility to rooms*', '*the location of the rooms and their relationship to the wards*', '*daylight'*, 'light in the rooms', 'circulation around the patient', 'lack of showers in rooms', 'infection control', 'air quality' and the 'final finishes'. These ones are shown in the following transcripts.

> *"Room layout and access to and around the patient" (Designer 1)*
> *"Rooms" (Designer 6)*
> *"The location of the en-suite and the relationship of the en-suite to the patient bedroom usually informs the initial discussion for ward layouts. 'Nested' 'inboard' or 'outboard' all have design implications and patient privacy, visibility and safety pluses and minus'. Handing/Mirroring of bedrooms also brings about heavy and varied user discussions" (Designer 9)*
> *"Access and signage" (Designer 26)*
> *"…Shower facilities" (Designer 22)*
> *"Patient falls, light, noise, infection control, medication errors, flexibility/adaptability, family zone Room area based on the various healthcare standards vary from country to country Patient visibility for nursing staff" (Designer 21)*
> *"Space and storage, air quality/ temperature" (Designer 22)*

"Infection control" (Designer 24)

Three designers had opposing opinions regarding single rooms' layout. As two stated that, the overuse of single rooms affects the circulation in spaces and the workflow as well as the observation, while the third designer said that it would help in having a good visibility and adequate space.

> *"Over use of single bed rooms makes nursing more difficult. It is more efficient to administer care to 4 patients in a four bedded bay than in 4 individual rooms. Single bed rooms generate increased circulation space resulting in more time spent moving from bedroom to bedroom. Insufficient storage. There is never enough no matter how much is provided."(Designer 4)*
>
> *"Reduced observation opportunities of Single Bedrooms Sufficient working space and patient space" (Designer 13)*
>
> *"Assuming we are talking about single bedrooms here rather than multi-bed bays: good visibility from corridor into the bedroom for staff observation, adequate space around bed for staff, standardisation of room layout" (Designer 23)*

The second and third sub-theme ***'Patient comfort and safety'*** and ***'Staff (comfort and safety issues)'*** have also been discussed by many respondents who showed that it is another important issue, which designers get feedback on. Among the responses, the following codes have been identified that are: '*personal needs', 'disabilities', 'observation', 'furniture placement', 'sightline to bed', 'noise', 'privacy and dignity', 'safety'* and *'patient falls'*. The following transcripts illustrates the sub-themes and codes cited above.

> *"...Observation into room from staff base and touch down stations whilst still maintaining privacy and dignity for the patient." (Designer 1)*
>
> *"During the design process clinical functionality is the most fundamental issue and deals with workflow and safety. Once that is in place then quality of the patient and visitor environment with privacy and dignity a primary concern." (Designer 2)*
>
> *"1. Prevention of falls 2. staff being able to observe patients in single bedrooms through observation screens without necessarily entering the room and maintain a line of sight to the head of the bed" (Designer 3)*
>
> *"Patient dignity, the care quality environment Clinical function" (Designer 5)*
>
> *"Noise and privacy" (Designer 7)*

"Control of infection; patient observation by staff; privacy & dignity; safety/slip-resistance" (Designer 8)

"Insufficiency of adequate storage space Privacy and dignity" (Designer 10)

"Temperature (too hot/ too cold), noise (too noisy, too much noise from other spaces) and odour (from toilets or cleaning products) are the most tangible issues as they are easier to explain rather than subjective issues like look or feel"(Designer 11)

"Noise, lack of privacy, dirt, insufficient staff numbers (clinical and support but mostly the latter) Badly planned spaces with placement of fittings and furniture inappropriate" (Designer 14)

"Lack of door hold opens (many are Value Engineered out) Lack of storage space (site/space is limited and it is storage rooms that are removed)" (Designer 15)

"From staff, the things that get used daily - taps, electric points, blinds, storage - generally in the form of complaints about things that don't work." (Designer 17)

"Infection control. Fire Strategy. Privacy and dignity. Same sex accommodation. Provision of ensuite shower rooms. Daylight. Air quality. The final finish and interior design. Increased or reduce amount of space. Modern technologies. Changes to working practices brought about by a different layout." (Designer 20)

"Staff efficiency" (Designer 27)

"Privacy" (Designer 29)

One of the designers said that they rarely get good feedback and it would be great if they could. *"We rarely get good feedback once a given scheme is in use. This would be a huge asset" (Designer 17)*.

The fourth sub-theme ***'cost'*** has been discussed as another important issue *"Usually this is lack of storage from NHS staff - when it has been squeezed out by increasing other areas/ costs."* (Designer 16).

Regarding Theme 2 **'Design Guidance'** one sub-theme has been retrieved *'codes and practice notes'* the following codes have been identified that are *Health Building Notes (HBNs)* and *Health Technical Memoranda (HTMs)* as one designer identified them. *"Infection Control Compliance. Compliance to HTM's and HBN's is often high on the clients' agenda." (Designer 19)*

4.1.2.2 Q.2) Which issue (s) do you find the hardest to address, and why?

In this question, two themes **'Design Matters'** and **'Design Guidance'** have been notified and discussed in the responses of the participants. Of twenty-nine designers, Twenty-six expressed their opinions regarding the hardest issues they deal with. Surprisingly, two designers did not express their views *"N/A"* (Designer 25, 28); while one designer stated that *"having worked solely in healthcare for a number of years we have good standard procedures for designing these types of rooms."* (Designer 18)

In terms of **'Design Matters'**, the following sub-themes were retrieved starting with ***'clinical good practice'*** that included *'infection control'*, *'single rooms'*, *'care type and pathways'*, *'adaptability and flexibility'*, *'optimal adjacencies'*, *'circulation spaces'*, *'room area'*. These are shown in the following transcripts.

> *"The general accepted palette of materials that address cleaning regimes necessary to manage infection control and reduce the incidence of trips and slips can generate an austere and institutional feel." (Designer 4)*
> *"There are differing views on the design of 100% single bedrooms. 100% single rooms has [sic] benefits for infection control and flexibility but requires a different approach to nursing workflow. Many older patients say that they prefer multi bedded rooms." (Designer 2)*
> *"…Varying interior design concepts is always a challenge. (Designer 4)*
> *"patient flow/journey/care pathways - acute to primary to social care"(Designer 5)*
> *"Flexibility of space due to the specific clinical functions required." (Designer 7)*
> *"Temperature is quite difficult because everyone feels it differently (young/ old, male/ female, level of clothing, fever etc.) Providing local control is the best way to please the occupants but is not the most energy efficient as you may have adjacent rooms all at different temperatures and rooms being cooled when no-one is in the room" (Designer 11)*
> *"Minimising circulation spaces and achieving optimal adjacencies due to limited floor plate areas. Discrete installation of building services whilst maintaining adequate servicing and maintenance provision." (Designer 10)*
> *"A standard 18m2 single room with a nested bathroom -ie. one to the side - rather than inboard or outboard- addresses all of the principal issues and allows views in*

and out of the room and a direct contact between the nursing corridor and the room..” (Designer 12)

“Room area to provide the best environment for patients, staff, visitors within the cost restrictions/budgets” (Designer 21)

“Bathroom design, due to pressures on space we often get issues with water flowing from flat floor showers to the door Ventilation.” (Designer 22)

“Contradiction between good design practice for accessible design and dementia design.” (Designer 19)

“Environmental pressures to reduce reliance on mech vent means cooling is at a premium. Heating - to provided more floor space and reduce dust traps, ceiling heating is often used, but this often does not deliver the comfort people want.” (Designer 22)

“Natural light (when refurbishing old hospitals, we need to deal with what we have)” (Designer 24)

The second sub-theme is ***‘Patient comfort and safety’***. This included *‘personal needs’, ‘disabilities’, ‘observation’, ‘sightline to bed’, ‘noise’, ‘privacy and dignity’, ‘safety’, ‘patient falls’, ‘daylight’, ‘privacy’, ‘type of materials’, ‘nursing workflow’, ‘accessibility to views’, ‘patient visibility’, ‘temperature’, ‘HVAC’* and *‘building services installation’*. These are extracted in the following transcripts.

“Access to daylight and an interesting view outside when dealing with large, inner city hospitals” (Designer 3)

“Light and colour” (Designer 8)

“Patient privacy vs patient visibility and therefore safety is a hard one to balance. Patient privacy is very important, but this needs to be carefully balanced with the patient not feeling isolated. Also, from a staffing/nursing perspective - seeing the patient and visibility from the corridor for example is very important for patient safety.” (Designer 9)

“Noise” (Designer 14)

“The conflict of daylight & views out versus privacy is difficult. This may be related to the site & orientation of the building and potential overlooking issues, and is compounded by infection control issues, where blinds/curtains cannot be specified and there is not enough money to provide interstitial blinds.” (Designer 16)

The third sub-theme is ***'staff comfort and safety issues'*** and this included *'security'*, '*productivity', 'walking distances', 'sightline from touch down stations', 'ergonomics'* were extracted from the responses as shown below;

> *"Observation versus privacy is often the most difficult to resolve. Use of materials to provide a visually attractive room to help with wellbeing often conflicts with the requirements of control of infection." (Designer 1)*
>
> *"Theatre requirements" (Designer 6)*
>
> *"...Also allows borrowed daylight into the nursing corridor which hugely improves the quality of life for the staff". (Designer 12)*
>
> *"Balance of observation in, views out and location of en-suite. Cost and floor space required for best solution - stacked en-suites Minimising the clinical feel and improving the healing environment without making it harder to provide the clinical care" (Designer 13)*
>
> *"Clinicians rarely appreciate how and where waste is disposed of or how clean/dirty linen is accommodated" (Designer 5)*
>
> *"Loose furniture placement as it is usually outside of the designer's control; excessive loose equipment left in rooms and corridors."*(Designer 8)
>
> *"Long corridors create large walking distances for staff and increase the number of staff required in the ward. Adequate space provision for staff rest room [sic] on the ward, space for equipment and support services (linen, WCs)"* (Designer 23)

The fourth sub-theme ***'cost'*** was found in the following responses:

> *"Privacy (costs)" (Designer 29)*
>
> *"Funding / spending. User engagement / understanding of the proposal. How the healthcare facility operates beyond its immediate clinical boundary" (Designer 5)*
>
> *"Insufficient funding to provide the correct building materials Lack of storage space (always lost because of cost issues)" (Designer 14)*
>
> *"Where the solution that the users will accept is simply unaffordable, or in direct contradiction of a pre-existing contract." (Designer 17)*
>
> *"Achieving space standards within budget" (Designer 27)*

In terms of **'Design Guidance'**, the following sub-themes were retrieved ***'codes and practice notes'*** for example HBNs, HTMs. These are shown in the following transcripts.

> *"How to design a comfortable welcoming space without making it look too institutional due to having to comply with HTM's on say finishes etc." (Designer 19)*
> *"Providing the desired amount of space due to budget and hospital estate constraints. Often we are dealing with refurbishment or reconfiguration projects, therefore we have to design within a set space. HBNs and HTMs provide the guidance on the ideal amount of space and often there is too much pressure on the Trust to provide an increase capacity for patient through-put, which then affects its ability to stick to the guidance. Reconfiguration can bring about bad feeling because this may mean that someone may be losing their job. Integration of IT infrastructure and providing future proofing capacity - no one can see the point of it." (Designer 20)*
> *"...Others Creating fully HBN compliant en-suites" (Designer 23)*

The second sub-theme that has been notified in the issues is ***'specifications'***. The codes that were identified are *'user engagement'*, *'meeting client expectation'*, *'cost issues'*, *'space required'* as shown in the following transcripts.

> *"Introducing materials that vary from the accepted norms to provide a warmer and non-institutional environment but still satisfying cleaning and slip resistance is often difficult for NHS Estates teams (Client) to accept." (Designer 4)*
> *"Meeting client expectations - the client wishes to have all singing and all dancing unit but there is limited space and costs in which to achieve this, so compromises need to be made" (Designer 15)*
> *"Non subjective matters where personal opinions and views are considered and not reviewed against the design brief combined with the technical requirements" (Designer 26)*

4.1.2.3 Q.3) Which issue (s) you feel most comfortable in dealing with?

In this question, two themes **'Design Matters'** and **'Design Guidance'** have been identified and discussed in the responses of the participants. Of the twenty-seven respondents, two designers did not express their views *"N/A"* (Designer 12, 28). Three other respondents

noted as healthcare designers they need to find solutions and deal with all issues, and compromise them with the regulations as illustrated in the transcripts.

> *"All the issues, together with those that I have added need to be addressed and it is not an issue of feeling comfortable or otherwise in dealing with them - that is our job as hospital designers." (Designer 2)*
>
> *"All, as specialists with many years' experience we enjoy designing elements to deal with all issues." (Designer 7)*
>
> *"Most issues, as there's always a design solution, although it may be a slight compromise from the original design solution to hit the regulations" (Designer 19)*

In terms of **'Design Matters'**, the following sub-themes were retrieved starting with ***'clinical good practice'*** that included *'infection control'*, *'single rooms'*, *'care type and pathways'*, *'adaptability and flexibility'*, *'optimal adjacencies'*, *'circulation spaces'* and *'room area'*. These are shown in the following transcripts.

> *"Repetition of layout," (Designer 3)*
>
> *"Room layout and equipment use. Organisation of the ward relationships as a whole." (Designer 1)*
>
> *"Space planning" (Designer 14 and 16)*
>
> *"Planning a ward to provide efficient planning and supervision to establish the basis for a good operational unit" (Designer 15)*
>
> *"Adaptable and flexible room layout design." (Designer 18)*
>
> *"Space planning… interior design, specification for finishes etc..." (Designer 20)*
>
> *"Bedroom model (inboard, outboard or nested model)" (Designer 23)*
>
> *"Interior finishes" (Designer 25)*
>
> *"Layouts" (Designer 27)*
>
> *"Infection control measures" (Designer 20)*
>
> *"Observation from corridor into bedroom, touchdown bases" (Designer 23)*
>
> *"Protection from falling, colours and finishes" (Designer 24)*
>
> *"Air quality" (Designer 29)*

The second and third sub-theme ***'Patient comfort and safety'*** and ***'Staff (comfort and safety issues)'*** have also been discussed by many respondents who showed that it is another important issue, which designers feel most comfortable in dealing with. Among the responses, the following codes have been identified that are: *'personal needs'*, *'disabilities'*,

'observation', *'sightline to bed'*, *'noise'*, *'privacy and dignity'*, *'safety'* and *'patient falls'*. The following transcripts illustrates the sub-themes and codes cited above.

> *"...Placing of furniture are all easy issues to co-ordinate and design and test with layouts, 3d models and live navigation using BIM." (Designer 9)*
> *"Provision of safe environment Best practice layouts" (Designer 13)*
> *"Patient observation" (Designer 3)*
> *"Visual and acoustic privacy" (Designer 6)*
> *"Patient observation & visibility of staff; daylight and views;" (Designer 8)*
> *"Access to natural light, colour palettes used" (Designer 9)*

The fourth sub-theme ***'cost'*** has been discussed as another important issue *"Realistic operational matters" (Designer 26)*.

Regarding Theme 2 **'Design Guidance'**, two sub-themes have been retrieved ***'codes and practice notes'*** and ***'specifications'***. These include the following codes *'HBNs'*, *'HTMs'*, *'statutory regulations'*, *'client requirements'* and *'briefing'*.

> *"Technical delivery and knowledge of current guidance and legislation" (Designer 10)*
> *"As a building services engineer, we can influence temperature, noise, light etc so we should be able to deal with those but there is often a lot of interaction with other members of the design team (e.g. facade for shading, partition thicknesses and construction for noise) to get it right" (Designer 11)*
> *"We have to keep up with current healthcare trends for clinical delivery, staff retention, patient focus." (Designer 21)*
> *"Spatial and statutory requirements" (Designer 22)*
> *"Most issues can be dealt with if there is support and informed decision makers on the Client side. Often Clients are unable to respond to key decisions that need to be made." (Designer 4)*
> *"Brief establishment Clinical / end user engagement Design response" (Designer 5)*
> *"Stakeholder engagement." (Designer 10)*
> *"I like dealing with users generally, but it's markedly easier if they are enthusiastic..." (Designer 17)*

4.1.2.4 Q.4) Are there any other user acceptance issues that you face during the design of the patient's room?

Of the twenty-nine designers, one said that they always receive a lot of feedback but it should not be the case as they redesign the wheel *"many, all the time but it shouldn't be so. We always redesign the wheel" (Designer 14)*. Surprisingly eight designers did not express their views *"N/A" (Designer 3, 6, 13, 18, 23, 25 and 28) "None that I recall" (Designer 24)*.

Twenty designers expressed their opinions regarding the user acceptance issues that designers face during the design of the patient's room, from which two main themes **'Design Matters'** and **'Design Guidance'** have been identified and discussed in the responses of the participants. The first sub-theme ***'clinical good practice'*** was addressed by many respondents indicating other user acceptance issues they face during the design of patient rooms. Among the responses, the following codes have been identified: '*accessibility to rooms*', '*the location of the rooms and their relationship to the wards*', '*daylight'*, *'light in the rooms', 'circulation around the patient', 'lack of showers in rooms', 'infection control', 'air quality'* and *the 'final finishes'*. These ones are extracted in the following transcripts.

> *"The location of the en-suite relative to the bedroom. There are generally 3 accepted permutations. Often there are varying views within a Client team about how the en-suite should be laid out." (Designer 4)*
>
> *"Very differing views on same-handed or mirrored room layouts; level of accessibility and assist-ability required for en suite shower/WCs." (Designer 8)*
>
> *"Size! Users always want more space, more storage, more equipment" (Designer 9)*
>
> *"Good outlook from the rooms if possible, is also key" (Designer 19)*
>
> *"Not just patient rooms, but the whole ward environment: IT infrastructure. Lack of staff facilities. Lack of storage, reduced sizes due to lack of space. We try to integrate design features which make the spaces easier to use if it is necessary to have them under-sized." (Designer 20)*
>
> *"Room layout and placement of furniture and electrical points." (Designer 22)*
>
> *"Design" (Designer 29)*
>
> *"Clinical issues dealing with infection control reduces the possible use of more domestic finishes." (Designer 7)*

"Meeting infection control requirements. They are requiring higher and higher standards (understandably) but they come at a cost, mainly in space which impacts on area and increases actual costs." (Designer 15)

The second sub theme ***'Staff (comfort and safety issues)'*** has also been discussed by many respondents. Among the responses, the following codes have been identified that are: *'observation', 'furniture placement', 'sightline to bed', 'noise', 'privacy and dignity'and 'safety'*. The following transcripts illustrates the sub-themes and codes cited above.

"Observation vs accessibility vs daylight. Achieving optimal solutions for each of these three issues often results in compromised solutions." (Designer 10)

"We do a lot of work abroad and it is interesting to note that some of the issues which we consider important in the UK such as monitoring the patient visually from outside the room are of little or no interest in some countries" (Designer 12)

The third sub-theme ***'cost'*** has also been discussed *"...and unfortunately, budget and/or size constraints for the building mean this is never usually possible." (Designer 9)*

Regarding Theme 2 **'Design Guidance'**, two sub-themes have been retrieved ***'codes and practice notes'*** and ***'specifications'***. These include the following codes *'HBNs'*, *'HTMs'*, *'statutory regulations'*, *'client requirements'* and *'briefing'*.

"Where user experience contradicts HBN guidance. The industry is so wedded to the HBNs that it is very difficult to get design solution that do not meet them approved - even if they are specifically requested by users." (Designer 17)

"Usually managing local requirements against national standards" (Designer 27)

"The ability to open windows is a common user demand and one that does not always sit alongside the environmental design. It is common for single bedrooms to require a high air change per hour as these are classed as treatment rooms as treatment will often be delivered in those spaces. The required air change will necessitate mechanical ventilation systems rather than a natural ventilation strategy - opening windows can adversely effect [sic] the mechanical system." (Designer 2)

"We need to discuss and agree the number and type of outlets in each rooms (e.g. power sockets, medical gases, data, TV etc.)" (Designer 11)

"Most often it is the conflicting requirements of the different user groups each of which have their own priorities and all of which need to be managed. Sometimes entrenched opinions from user groups based on practice are difficult to overcome." (Designer 1)

"Strong Client leadership is required." (Designer 4)

"Too many opinions from different groups as 'consultation' expands beyond the key core User Groups" (Designer 5)

"We do not normally meet with the patients during the design process. The input from Patient Groups is normally managed by the NHS Design Managers. Staff sometimes are reluctant to embrace new ways of working and want something 'the way it is now' rather than change to more modern ways of working." (Designer 16)

"Providing user choice and the flexibility to allow them to inject some of their own personality into the room, i.e. whether personal belongings etc. is important." (Designer 19)

"A solution that is agreed by all (or most) of the stakeholders" (Designer 21)

"If the design process is followed and there is a continual engagement, review and approval process this works well." (Designer 26)

4.1.2.5 Q.5) The above questions are about general hospital wards, In terms of adults' inpatient wards.

A) what are the main criteria of designing them?

Two designers did not express their views regarding the design criteria of adults' inpatient wards as one said that he is not responsible for the design of wards *"N/A to my role" (Designer 28)*. Another designer said they do not design hospital but they are special for the design of hospices *"Please note our practice doesn't design hospitals, only hospices and health centres" (Designer 18)*. Whereas twenty-seven designers responded to this question by expressing their views, from which two main themes **'Design Matters'** and **'Design Guidance'** have been identified and discussed in the responses of the participants.

In terms of **'Design Matters'**, the following sub-themes were retrieved ***'clinical good practice'*** that included *'infection control'*, *'single rooms'*, *'care type and pathways'*, *'adaptability and flexibility'*, *'optimal adjacencies'*, *'circulation spaces'*, *'room area'*. These ones are shown in the following transcripts.

"We usually aim to design standard layouts for adult inpatient wards for flexibility, staff familiarisation; buildability and ease of maintenance." (Designer 8)

"All general and adult in-patient wards should be flexible enough to cope with elderly care and adult care." (Designer 13)

"General medical/surgical wards are flexible" (Designer 21)

"The main criteria of designing are: - Functionality - Security (fire protection, X-ray protection, sound protection etc." (Designer 25)

"In relation to the type of wards that again have further technical parameters controlling environments and functional relations to other spaces will be required" (Designer 26)

"Layout - achieving flexibility, observation and efficient staffing together with high quality patient spaces with daylighting, views etc." (Designer 27)

The second sub theme ***'Staff (comfort and safety issues)'*** has also been discussed by many respondents. Among the responses, the following codes have been identified that are: *'observation', 'furniture placement', 'sightline to bed', 'noise', 'privacy and dignity'* and *'safety'*. The following transcripts illustrates the sub-themes and codes cited above.

"Usually space requirements and the level of close staff observation spaces." (Transcript, 4)

"Understanding the clinical function / environments staff / clinical ratios M&E servicing requirements spatial arrangements / planning" (Designer 5)

"The greater the specialty the greater the specific knowledge of previous solutions and installation becomes. Understanding the clinical process and the spatial requirements/movements is fundamental to good design. We spend a lot of time observing the processes to understand the ergonomics and the technical requirements of specialist equipment." (Designer 10)

"Important to get staff movement and supplies, rapid access, storage requirement analysed and sorted out. Patient is a patient and needs are similar except for specialist care" (Designer 14)

"Bed bay space varies depending on the equipment needed around the bed" (Designer 24)

"Good visibility from staff base; temperature control per bay; ventilation" (Designer 24)

Regarding Theme 2 **'Design Guidance'** two sub-themes have been identified ***'codes and practice notes'*** and ***'specifications'***. These include the following codes *'HBNs*', *'HTMs'*, *'statutory regulations'*, *'client requirements'* and *'briefing'* that are shown in the extracted transcripts.

> *"HTM / HBN and other statutory documentation. Models of care, adjacency matrix, room data sheets, knowledge of good practice."*
> *(Designer 2)*
> *"Hospital wards do have specific requirements spatially and are defined in various HTM`s and HBN`s." (Designer 26)*
> *"Client requirements" (Designer 6)*
> *"Firstly, examining the demographic of the patients and staff for different wards to establish what is required." (Designer 15)*
> *"Number of single beds v bed bays. Types of rooms - isolation and en-suite requirements." (Designer 18)*
> *"Nursing/staffing ratios. Adjacencies to other departments. Engineering - positive/negative pressure regimes. Isolation facilities. Number of sanitary facilities. Provision of dirty utilities." (Designer 20)*
> ***"****Ancillary spaces need to be established at the outset, informed by client and consultants / users" (Designer 22)*

B) what are the main differences between them (such as burn centre, cardiology, intensive care, etc.)?

In this part, two main themes **'Design Matters'** and **'Design Guidance'** have been identified. One designer said that the differences depended on different visions *"Different divisions" (Designer 29)*. Another designer said that all criteria are similar in designing them but the difference lies in the location, observation and equipment in the room *"The principals in designing all wards are generally the same. The difference comes with the degree of observation required and the amount of equipment required at each station. Also, their location within the hospital for access to support services." (Designer 1)*

The first sub-theme ***'clinical good practice'*** was addressed by many respondents. Among their responses, the following codes have been identified: '*accessibility to rooms*', '*the location of the rooms and their relationship to the wards*', '*daylight'*, *'light in the rooms'*, *'circulation around the patient'*, *'lack of showers in rooms'*, *'infection control'*, *'air quality'* and the *'final finishes'*. These ones are shown in the following transcripts.

"Palliative care - access to outdoors, include a bathroom, much more homely feel - less clinical if possible. Intensive care – larger rooms, central bed location - use of pendants for services, visibility between rooms and into rooms is really important. Often without en-suite. Rehabilitation ward - access to outdoors, access to a therapy space - or larger rooms for therapy to take place within the rooms. Spinal injury ward - often initial feelings of depression and hopelessness experienced by patients - twin rooms, or rooms which can be opened up to each other, and pairing of patients to each other - where one patient is further on in recovery can aid new patients with feelings of hopelessness and what will happen to them." (Designer 9)

"Vague question: Burns units are specialist and seem to vary from hospital to hospital. main issues: proximity to theatres /routes to and from / size of rooms. Cardiology: CCU units require larger rooms and telemetry and higher staffing ratios." (Designer 12)

"Specialist care rooms need to provide the required FF&E" (Designer 13)

"The models of care will inform differences between ward types and this will typically include observation standards, level of nursing, isolation and infection control requirements. Equipment and access requirements will inform space standards." (Designer 2)

"Isolation rooms need lobbies Burn centres will need humidity control Intensive care will need higher ventilation air change rates" (Designer 11)

"The main difference is the integration of services. More specialist facilities will tend to have a greater volume of services, and may have higher standards for cleanliness / maintenance etc. Most specialist facilities also have increased space requirements and more varied equipment requirements." (Designer 17)

"Single room occupancy changes with sue type. Services requirements more onerous with more intensive care." (Designer 22)

"Intensive care rooms are much larger then [sic] a typical bedroom; they include pendants and other life support systems and services. Have a one-to-one staff-to-patient ratio. Higher ventilation requirements" (Designer 23)

"Specific considerations for specialist areas comes from patient needs e.g. greater observation, isolation, special equipment e.g. pendants in intensive care" (Designer 27)

The second and third sub theme ***'Patient comfort and safety'*** and ***'Staff (comfort and safety issues)'*** have also been discussed by many respondents. Among the responses, the following

codes have been identified that are: '*personal needs', 'disabilities', 'observation', 'furniture placement', 'sightline to bed', 'noise', 'privacy and dignity', 'safety'* and *'patient falls'*. The following transcripts illustrates the sub-themes and codes cited above.

> *"In ICU, HDU, burns units the requirements for staffing, patient to staff ratios and observation requirements are much higher to the generic ward. So these are not classed as general wards." (Designer 3)*
>
> *"Due to the level of acuity each department will require differing levels of need. For example an ICU requires much higher ventilation rates and air filtration to deal with possible infections. As such the co-ordination of building design, service elements and structure requires specific attention. Levels of observation are also much higher and require the design of the layout to accommodate lines of sight and reduced travel distances to medication, supplies etc..." (Designer 7)*
>
> *"All the critical issues -daylight / space / views / etc remain the same ICU: rooms need to be big enough to accommodate all the paraphernalia on the pendants when they swing round - choice of pendant critical - currently the Draeger [sic] one id the best on the market in that they are very slimline [sic] whilst ultrapractical [sic] and allow the patient to be both nursed and supported. Rooms all need daylight and views and the right balance of immediate and remote storage. It's a high-pressure high staffing unit and needs to be carefully designed to maximise staff amenity with regard to space, light and hunter gathering." (Designer 12)*
>
> *"Elective Care wards would require social spaces to encourage patients to get up and move, others in intensive care don't need that support as they are completely bed bound. Staff will need lots of small hot desks throughout the elective care ward but in intensive care wards the need is for larger staff base areas with full supervision of their patients." (Designer 15)*
>
> *"Each type of ward may have its own specific clinical needs e.g. isolation or enhanced air quality, however the majority of hospitals we design have an element of flexibility" (Designer 16)*

Regarding Theme 2 **'Design Guidance'** one sub-theme has been retrieved ***'specifications'*** the following codes have been identified that are *'statutory regulations'*, *'client requirements'* and *'briefing'*.

> *"Once the unit is specialty (i.e. burns, ICU, Cardiac, ortho, neuro), the requirements will change based on the specific hospital system or trust in how they deliver the care.*

Each organization has unique requirements, based on if it's a specialty stand-alone hospital, a tertiary facility, part of a medical teaching campus, etc." (Designer 21)

"Spatial, more intensive means bigger spaces, more emphasis on ventilation strategies." (Designer 22)

4.1.2.6 Q.6) What data currently supports your day-to-day tasks for the design of hospital wards?

In this question, one theme **'Design Guidance'** has been identified and discussed in the responses of the participants. Two designers did not express their views *"N/A" (Designer 1, 2)*. One designer said that it is not his responsibility *"n/a to my role" (Designer 28)*.

Twenty-six designers expressed their opinions regarding the current data that supports designers' day-to-day task for the design of hospital wards, from which three sub-themes were identified ***'codes and practice notes'***, ***'specifications'*** and ***'experiential feedback'***. These include the following codes *'HBNs'*, *'HTMs'*, *'statutory regulations'*, *'client requirements'*, *'briefing'*, *'experience'*, *'Post occupancy evaluation' and 'case studies'*. These ones are shown in the following transcripts.

"HBNs" (Designer 3, 17 and 23)

"Health Building Notes and Health Technical Memorandum." (Designer 4, 11, 18, 24)

"HTM's, HBN's, etc. basic compliance" (Designer 5)

"Leed Criteria" (Designer 6)

"HBN; British Standards, Approved Building Regulations documents, knowledge sharing and best practice, and evidence-based design research." (Designer 9)

"Current HBNs / HTMs. P22 repeatable room data. Global Best practice guidance and EBD examples" (Designer 10)

"HBN / HTM and other guides - practice digital library" (Designer 12)

"HTM layouts as loose baseline standard" (Designer 13)

"Guidance documentation" (Designer 15)

"HBNs, HTMs, EBD" (Designer 16)

"ADB standard rooms, equipment lists. Statutory Regulations such as Building Regulations" (Designer 16)

"HTM's and Clinical Care Standards" (Designer 19)

"HBNs, HTMs, BS8300. DoH Activity Data Base Room Data Sheets and department lists. BIM models. Client Schedules of Accommodation." (Designer 20)

"FGI, HBN, HTM, Australasian Guidance" (Designer 21)

"HTM / HBN, P21 example rooms" (Designer 22)

"- Activity data base, - Manufacturer planning guides" (Designer 25)

"ADB (Activity Data Base), HTM`s, HBN`s" (Designer 26)

"Client Requirements" (Designer 6, 24)

"..Along with user consultation. Peer reviews." (Designer 15)

"Hospital facilities and strategic planning groups, user groups (Designer 21)

"Regulation and medical staff / hospital management requirements" (Designer 29)

"Post-occupancy evaluations and research studies; benchmarking; patient and staff feedback; study tours and desk-top studies." (Designer 8)

"Recent project experience/ interaction with the client" (Designer 11)

"Personal and colleagues' experience" (Designer 3)

"Very little. Our experience and knowledge is our main support." (Designer 7)

"My tacit knowledge/expertise and pattern language" (Designer 14)

"Experience" (Designer 15)

"References to Architectural journals, visits to new facilities." (Designer 16)

"..And case studies of facilities in use" (Designer 17)

"Extensive previous experience" (Designer 18)

"Journals on best practice, trends, research (in house and by others)." (Designer 21)

"DIMH forums, colleague support and experience. HIS" (Designer 22)

"Personal and colleagues' experience, other precedents" (Designer 23)

"Case studies of previous projects, standards" (Designer 27)

4.1.2.7 Q.7) What further data would ideally improve/ enhance your day-to-day task for the design of a hospital ward?

In this question, only one theme **'Design Guidance'** has been identified and discussed in the responses of the participants. Five designers '17.24%' did not express their views *"N/A" (Transcript 1, 2, 3, 18, and 23)*

One designer said that the data is sufficiently available *"I FIND THE DATA AVAILABLE SUFFICIENT" (Designer 24)*.

Twenty-three designers expressed their opinions regarding further data that would enhance day-to-day task for the design of hospital wards, from which three sub-themes were identified ***'codes and practice notes'***, ***'specifications'*** and ***'experiential feedback'***. These include the

following codes *'HBNs*', *'HTMs'*, *'statutory regulations'*, *'client requirements'*, *'briefing', 'experience'*, *'Post occupancy evaluation'*, *'EBD libraries'*, *'best practices'*, *'old HBN diagrams' and 'case studies'*. These ones are shown in the following transcripts.

"BMS, occupancy" (Designer 6)

"A standard schedule of accommodation and space standards - currently NHS guidance does not include these although it did in the past." (Designer 8)

"I used to find previous HBN diagrams much more useful in terms of meeting standards and minimum space requirements. The newer versions of HBN where the space activity drawings are used instead - makes working to minimums or standards a lot more laborious looking up several activity space diagrams to get one space requirement. I understand why they changed the standards, but it makes looking things up and checking can be open and take much longer." (Designer 9)

"Good question - access to the Pebble Projects (Centre for Health Design) database and other evidence-based libraries" (Designer 12)

"Agreed baseline standard maintained and developed (similar to Procure 22 repeatable rooms)" (Designer 13)

"Up to date HBNs and HTMs" (Designer 14)

"More accessible example rooms and data sheets that clearly demonstrate compliance and provide different options. ADB system is no longer controlled by the NHS and is out of date. P21 example rooms can only be accessed by registering the scheme. A need for a central resource that that retains up to date information for designers including best practices in layout and technological design and recent health alerts and bulletins. Feedback form recently constructed schemes. HBN should contain example rooms with overall dimensions clearly shown. The information always leaves gaps and this leads to confusion." (Designer 22)

"Activity Data Base" (Designer 25)

"Contemporary guidance available online, that has been updated along with current practice. Some of the HTM`s and HBN`s are outdated" (Designer 26)

"Recent case studies." (Designer 4)

"Clinician understanding of design, limitations, funding" (Designer 5)

"Recovery rate for patients within a new facility in comparison to that of a historic ward based on layout, natural light and views, natural ventilation, colour etc.." (Designer 7)

"Greater knowledge of the clinical outcomes of design decisions so that evaluation and understanding of the effects of various design solutions was more available for use in future development." (Designer 10)

"Feedback from existing facilities (old and new) about what works and what doesn't work"

(Designer 11)

"More access to physicians and nurses - insights that challenge orthodoxy." (Designer 12)

"Better agreement across Health Boards, what is acceptable in one ward design in one region may not be acceptable to another region, regardless of national guidelines." (Designer 15)

"Consistent briefing information." (Designer 16)

"More post occupancy studies of completed schemes." (Designer 17)

"Data that substantiates good design improves patients [sic] wellbeing and recovery rates." (Designer 18)

"Examples of best practice principles for ward layouts and departmental arrangements." (Designer 20)

"POE from facilities across the globe! A library for this info would be great!" (Designer 21)

"Post occupancy feedback" (Designer 27)

"The link between the end-user feedback on one project to the design of the forthcoming project is always a problem. Frequently the same issues appear time and time again. For example, maintenance issues are always an issue. Something as simple as window cleaning is a real concern for the NHS but this concern is rarely taken account of in the design of the buildings. Some hospitals cost upwards of £7k to clean the windows per time. Due to design issues that could have been rectified earlier." (Designer 28)

"Evidence- based cost effectiveness of improvements in the design" (Designer 29)

4.2 HEALTHCARE SURVEY ANALYSIS

The second part of the data collection involved an online questionnaire assigned to healthcare users including staff (nurses, clinicians, allied health professionals) without patients. The survey was sent to two samples; the first sample was the staff in hospitals (these included students, clinicians and nurses), the second sample was healthcare professionals who used to

work in hospitals but had moved to academia and the third sector. The survey consisted of 5 categorical questions, 3 open-ended questions and 26 statements that required rating (using a Likert-scale). The survey questions to both groups were similar but with a change of tense: the present tense related to staff that are still working in hospitals (see Appendix 3), whereas the survey of healthcare professionals working in academia or the third sector (i.e. Charity foundation for disabled people) used the past tense (see Appendix 4). The survey data were analysed using the Statistical Package for Social Sciences (SPSS) software for descriptive and inferential statistics.

The first part of the analysis involved healthcare professionals working in hospitals, with 27 respondents (57.4%); and the second part of the analysis included healthcare professionals, working either in academia or in the third sector with 20 respondents (42.6%).

	Frequency	Percent	Cumulative Percent
Third Sector/ Academia	20	42.6	42.6
HC professionals and students in hospitals	27	57.4	100.0
Total	47	100.0	

Table 4.28: Staff in hospital and academia.

	Frequency	Percent	Cumulative Percent
HC professionals and students in hospitals & Third Sector/ Academia	47	100.0	100.0

Table 4.29: Healthcare users.

A comparison of Variables' means was undertaken to see if there was any significant difference in opinions between healthcare professionals working in hospitals and former healthcare professionals working either in academia or in the third sector. This was to explore whether the two sets of data should be kept separate or be merged. In the table below, 'F', value and significance level 'Sig.' have been taken in consideration to see the similarities between variables.

	Respondents	Group Statistics				
Variables	staff in hospital or staff in academia	N	Mean	Std. Deviation	F	Sig. 'ρ'
How well are/were the patient areas in your hospital orientated towards daylight?	Third Sector/ Academia	20	3.4500	.99868	.001	.972
	HC professionals and students in hospitals	27	3.4815	1.05139		
How long have you been working in the healthcare sector?	Third Sector/ Academia	20	3.5000	.88852	6.905	.012
	HC professionals and students in hospitals	27	2.0741	1.29870		
How long have you been working/did you work in a hospital?	Third Sector/ Academia	20	2.4000	1.31389	.072	.789
	HC professionals and students in hospitals	27	2.0741	1.29870		
When working in a hospital environment, do/did you prefer working in?	Third Sector/ Academia	20	1.4000	.50262	.156	.695
	HC professionals and students in hospitals	27	1.3704	.49210		
How good is/was the shading in the room to minimize the adverse effects of direct sunlight and solar exposure to patients?	Third Sector/ Academia	20	3.3500	.81273	1.946	.170
	HC professionals and students in hospitals	27	3.5926	1.08342		
How good are/were the artificial lights in the room?	Third Sector/ Academia	20	3.1000	1.20961	.882	.353
	HC professionals and students in hospitals	27	3.6296	1.00568		
The design of patient areas is very important to the patient's recovery and wellbeing	Third Sector/ Academia	20	4.7500	.44426	8.362	.006
	HC professionals and students in hospitals	27	4.3704	.68770		
A small communal ward, e.g., 4 to 6 bedrooms, provides a better recovery environment than a single patient bedroom	Third Sector/ Academia	20	3.1500	1.13671	.212	.648
	HC professionals and students in	27	3.2222	.89156		

	hospitals					
Patients have enough privacy in patient areas	Third Sector/ Academia	20	2.2500	1.06992	.016	.899
	HC professionals and students in hospitals	27	2.7407	1.02254		
The size of doors and doorways are important to accommodate all patients' needs	Third Sector/ Academia	20	4.6500	.48936	.005	.942
	HC professionals and students in hospitals	27	4.2222	.57735		
Windows are large enough to allow patients to have a pleasing view	Third Sector/ Academia	20	3.2500	1.25132	1.348	.252
	HC professionals and students in hospitals	27	3.6667	.96077		
The sound insulation is sufficient	Third Sector/ Academia	20	2.6000	1.04630	.016	.900
	HC professionals and students in hospitals	27	2.7778	1.01274		
The room air temperature is appropriate in the patients' areas	Third Sector/ Academia	20	3.2500	1.16416	.047	.830
	HC professionals and students in hospitals	27	3.3333	1.10940		
The patient areas are of adequate size	Third Sector/ Academia	20	3.1000	1.44732	16.678	.000
	HC professionals and students in hospitals	27	3.5926	.84395		
The quality of the clinical furniture in the rooms, e.g., bins, chairs, lockers, etc., affects the well-being and recovery of patients.	Third Sector/ Academia	20	3.8000	.76777	.947	.336
	HC professionals and students in hospitals	27	3.5926	.88835		
The placement of clinical furniture is well suited to the recovery of patients and effective staff working	Third Sector/ Academia	20	3.4500	.75915	.242	.625
	HC professionals and students in hospitals	27	3.5926	.69389		
The washing facilities are well suited to the recovery of patients	Third Sector/ Academia	20	3.1000	1.11921	.910	.345

and staff working	HC professionals and students in hospitals	27	3.5926	.93064		
Electric points are well suited to the recovery of patients and staff working	Third Sector/ Academia	20	3.4000	1.14248	6.817	.012
	HC professionals and students in hospitals	27	3.6667	.73380		
Window blinds are well suited to the recovery of patients and staff working	Third Sector/ Academia	20	3.2500	.85070	.029	.866
	HC professionals and students in hospitals	27	3.4815	.89315		
Equipment storage rooms are well suited to the recovery of patients and staff working	Third Sector/ Academia	20	2.8500	1.13671	2.169	.148
	HC professionals and students in hospitals	27	3.4074	.88835		
The sightline from the doctors' and nurses' stations to the patients is adequate	Third Sector/ Academia	20	2.6500	1.08942	.000	.984
	HC professionals and students in hospitals	27	3.0000	1.14354		
The visibility from the corridor to the patient rooms helps with patients' recovery	Third Sector/ Academia	20	3.3500	.74516	1.822	.184
	HC professionals and students in hospitals	27	3.3704	.96668		
The patients' dignity and privacy are maintained	Third Sector/ Academia	20	3.6000	1.14248	1.121	.295
	HC professionals and students in hospitals	27	3.6667	.87706		
The size of showers is sufficient to support the patients' recovery	Third Sector/ Academia	20	3.4000	1.27321	10.113	.003
	HC professionals and students in hospitals	27	3.7778	.69798		
Bathrooms' size is big enough for patient's recovery	Third Sector/ Academia	20	3.3500	1.26803	7.029	.011
	HC professionals and students in hospitals	27	3.6667	.73380		

The patients' bedrooms size is sufficiently large to support recovery	Third Sector/ Academia	20	3.7000	.97872	1.349	.252
	HC professionals and students in hospitals	27	3.6667	.78446		
Visitors have enough space to visit patients in their room	Third Sector/ Academia	20	3.1500	1.13671	.371	.546
	HC professionals and students in hospitals	27	3.2963	1.13730		
Communal space is well equipped and designed for patients' recovery	Third Sector/ Academia	20	2.9000	1.11921	.363	.550
	HC professionals and students in hospitals	27	3.1852	.87868		
The circulation areas are conducive to the recovery of patients	Third Sector/ Academia	20	3.0500	1.05006	.704	.406
	HC professionals and students in hospitals	27	3.3333	.62017		

Table 4.30: comparison of Variables' means between healthcare professionals in hospital and healthcare professionals (academia and the third sector).

The means in the table above do not show a big difference, and the significance level has to be less or equivalent to 0.05 (Mirabella 2006, Liu 2008, Mehta and Patel 2011), which means in the table there are only 6 variables out of 29 variables that are significant; hence 6 variables vary between two samples. On this basis, it was considered that both samples data could be merged within one sample as illustrated below. Respondents from both samples are more or less similar in their opinions, apart from few statements such as the bathroom size, size of showers, equipment storage, the circulation areas and the privacy in the patient areas.

All variables: Var-H_{osp}-1- Var-H_{osp}-7-2, Var-H_{acad}-1- Var-H_{acad}-7-2	
N	47
Valid	
Missing	0

Table 4.31: Sample size presented in the table with the variables.

Var-H_{osp}-1 means Variable of question 1 for healthcare professionals in hospital, and

Var-H_{acad}-1 means Variable of question 1 for healthcare professionals in academia and third sector.

The statistical table displays the sample size for the following variables, where Var-HC_{users}-1 means Variable of question 1 for healthcare users in hospital and academia.

- ***Var-HC_{users}-1: What is/was your role in the hospital?***
- ***Var-HC_{users}-2: How long have you been working in the healthcare sector?***
- ***Var-HC_{users}-3: How long have you been working/did you work in a hospital?***
- ***Var-HC_{users}-4: When working in a hospital environment, do/did you prefer working in: a- single patient rooms, b- an open ward?***
- ***Var-HC_{users}-5-1: How well are/were the patient areas in your hospital orientated towards daylight?***
- ***Var-HC_{users}-5-2: How good is/was the shading in the room to minimize the adverse effects of direct sunlight and solar exposure to patients?***
- ***Var-HC_{users}-5-3: How good are/were the artificial lights in the room?***
- ***Var-HC_{users}-6-1: The design of patient areas is very important to the patient's recovery and wellbeing***
- ***Var-HC_{users}-6-2: A small communal ward, e.g., 4 to 6 bedrooms, provides a better recovery environment than a single patient bedroom***
- ***Var-HC_{users}-6-3: Patients have enough privacy in patient areas***
- ***Var-HC_{users}-6-4: The size of doors and doorways are important to accommodate all patients' needs***
- ***Var-HC_{users}-6-5: Windows are large enough to allow patients to have a pleasing view***
- ***Var-HC_{users}-6-6: The sound insulation is sufficient***
- ***Var-HC_{users}-6-7: The room air temperature is appropriate in the patients' areas***
- ***Var-HC_{users}-6-8: The patient areas are of adequate size***
- ***Var-HC_{users}-6-9: The quality of the clinical furniture in the rooms, e.g., bins, chairs, lockers, etc., affects the well-being and recovery of patients.***
- ***Var-HC_{users}-6-10: The placement of clinical furniture is well suited to the recovery of patients and effective staff working***
- ***Var-HC_{users}-6-11: The washing facilities are well suited to the recovery of patients and staff working***
- ***Var-HC_{users}-6-12: Electric points are well suited to the recovery of patients and staff working***
- ***Var-HC_{users}-6-13: Window blinds are well suited to the recovery of patients and***

staff working

- ***Var-HC$_{users}$-614: Equipment storage rooms are well suited to the recovery of patients and staff working***
- ***Var-HC$_{users}$-6-15: The sightline from the doctors' and nurses' stations to the patients is adequate***
- ***Var-HC$_{users}$-6-16: The visibility from the corridor to the patient rooms helps with patients' recovery***
- ***Var-HC$_{users}$-6-17: The patients' dignity and privacy are maintained***
- ***Var-HC$_{users}$-6-18: The size of showers is sufficient to support the patients' recovery***
- ***Var-HC$_{users}$-6-19: Bathrooms' size is big enough for patient's recovery***
- ***Var-HC$_{users}$-6-20: The patients' bedrooms size is sufficiently large to support recovery***
- ***Var-HC$_{users}$-6-21: Visitors have enough space to visit patients in their room***
- ***Var-HC$_{users}$-6-22: Communal space is well equipped and designed for patients' recovery***
- ***Var-HC$_{users}$-6-23: The circulation areas are conducive to the recovery of patients***
- ***Var-HC$_{users}$-7-1: Which room layout, would be beneficial or helps you more in your day-to-day task?***
- ***Var-HC$_{users}$-7-2: Participants who opted for more than one layout of room***

The statistical table displays the sample size for all Variables. The table indicates that there were 47 valid observations for all Variables. There were no missing values for any of the variables. Variables were identified based on the findings of designers' survey, and the literature review (CABE 2004, Dalke et al. 2006, Koh et al. 2008, Mourshed and Zhao 2012, Zhao 2013). The next section will discuss the Variables and their frequencies. Variables are going to be named as follow: Variable 1 healthcare users (Variable-HC$_{users}$-1 for question 1, Variable-HC$_{users}$-2 for question 2) etc.

Variable-HC$_{users}$-1: What is your role in the hospital?

The following table illustrates the frequency of responses for Variable-HC$_{users}$-1 *what is your role in the hospital*.

Role in the hospital	Frequency	Percent	Cumulative Percent
A nurse	14	29.8	29.8
A doctor or medical associate	10	21.3	51.1
An allied health professional, i.e., occupational therapist, physiotherapist, etc.	18	38.3	89.4
Other:	5	10.6	100.0
Total	47	100.0	

Table 4.32: Interpretation of the findings for Variable- HC_{users}-1.

The first question investigates the role of each healthcare respondent, (i.e. a nurse, a doctor or medical associate, an allied health professional, a midwife and "other" category). In Table 4.32, the following figures are displayed: 10 doctors/ medical associates (21.3%), 18 allied health professionals (38.3%), 14 nurses (29.8%) and five respondents (10.6%) were identified in the 'Other' category that are a histopathologist, a pharmacist, a medical student, a senior nurse, and a health visitor.

Although the participants have different roles within the hospital and vary from one to another, their opinions were important to know the importance of each statement. The following Variables showed that they have similar thoughts and opinions, which why they were presented together.

Variable-HC_{users}-2: How long have you been working in the healthcare sector?

The following table illustrates the frequency of responses for Variable-HC_{users}-2 *How long have you been working in the healthcare sector*.

Years	Frequency	Percent	Cumulative Percent
0-4 Years	15	31.9	31.9
5-9 Years	6	12.8	44.7
10-15 Years	5	10.6	55.3
15 Years+	21	44.7	100.0
Total	47	100.0	

Table 4.33: Interpretation of the findings for Variable- HC_{users}-2.

This question investigates the length of the period of work in the healthcare sector that should be selected by respondents. The four categories of time include (0-4 years), (5-9 years), (10-15years) and 15 years+. In Table 4.33, 15 people out of 47 respondents (31.9%) selected the first category (0-4 years), followed by 21 people (44.7%) who worked more than 15 years+ in the healthcare sector. Six people (12.8%) worked from 5 to 9 years and five participants (10.6%) worked from 10 to 15 years.

Variable- HC_{users}-3: How long have you been working/did you work in a hospital?

The following table illustrates the frequency of responses for Variable-HC_{users}-3 How long have you been working/did you work in a hospital.

Years	Frequency	Percent	Cumulative Percent
0-4 Years	21	44.7	44.7
5-9 Years	9	19.1	63.8
10-15 Years	3	6.4	70.2
15 Years+	14	29.8	100.0
Total	47	100.0	

Table 4.34: Interpretation of the findings for Variable- HC_{users}-3.

This question investigates the length of the period of work in a hospital that should be selected by respondents. The four categories of time include (0-4 years), (5-9 years), (10-15years) and 15 years+. In Table 4.34, 21 people (44.7%) selected the first category (0-4 years), followed by 14 people (29.8%) who worked more than 15 years+ in a hospital. Nine people (19.1%) worked from 5 to 9 years and only 3 respondents (6.4%) worked between 10 and 15 years.

Variable- HC_{users}-4: When working in a hospital environment, do/did you prefer working in: *a- single patient rooms, b- an open ward*?

The following table illustrates the frequency of responses for Variable- HC_{users}-4 When working in a hospital environment.

Ward type	Frequency	Percent	Cumulative Percent
Single patient room	29	61.7	61.7
Open ward (multi bed rooms)	18	38.3	100.0
Total	47	100.0	

Table 4.35: Interpretation of the findings for Variable- HC_{users}-4.

This question investigates the preference for hospital wards (i.e. a single patient room, or an open ward multi-bed bays). Twenty-nine people chose to work in a single patient room, while 18 people (38.3%) preferred to work in an open ward multi bedrooms.

In the additional box, participants were asked to give a further explanation of the choice of room (single bedrooms or open ward). Twenty-nine participants in both academia and hospital practice, noted that single bedrooms have a positive aspect by offering privacy and confidentiality to patients as one of the respondents noted "offers more privacy to patients when discussing sensitive information, better for infection control". Another respondent commented "personal mental well-being being an essential part of the healing process, being with ones [sic] own gender gave the feeling of safety and respect". Single patient rooms could be better for children as claimed by one participant "Patients were happier in cubicles, the care you could provide was more dignified, I'm a paediatric nurse so if you have a child who's upset in the middle of the night it's a lot easier to console them without worrying about waking other patients." Another respondent noted "Paediatrics- Parents staying with children."

In addition to the confidentiality aspect where one respondent noted "patient confidentiality when speaking to patients"; "Patients were more comfortable. Less of a concern with breaking confidential information when talking to patients". In addition to the dignity aspect as one respondent claimed, "Better able to maintain privacy and dignity as well as confidentiality". Another respondent noted other advantages for the single patient ward that include less noise, less distraction "more privacy. Less noise and distraction" and dignity for patients during the treatment phase "There is more privacy and dignity for the patients when providing personal care. However, it is also important to note that single rooms can negatively impact on the patients [sic] psychological care too." They also prevent the spread of infection as one of the respondents noted "wards are generally very dynamic with a lot of things going on, so it's easier to concentrate and take your time in a private environment". Although one of the respondents chose single patient rooms he argued that open ward has advantages "Confidentiality although I think an open ward is perhaps socially better for patients - however this can be a good and bad thing". Another respondent chose single patient ward but claimed that open ward has better advantages as well "single room provide more privacy, and facilitate one to one care, more room for the medical staff on ward round. Open

ward provide more monitoring and care specially [sic] in elderly. In post operative [sic] patients open ward helps the patients to focus more on early mobilising and recovery."
Whereas 18 respondents said that, they preferred to work in an open ward because this facilitates the observation of all patients at the same time. Eight respondents claimed that open wards are better for patients' psychology where they can benefit from the discussion with other patients and staff, which helps in the process of their recovery as one noted "I am usually responsible for the care of a number of patients and an open bay is a more effective way of observing my patient indirectly. Additionally, the space is more sociable for patients who benefit from spontaneous discussions with staff and other patients. Single room set ups means I only go to the room if I deliberately intend to." Three respondents talked about the atmosphere that helps patients "more open atmosphere, allows patients to interact with each other as well as staff interacting with patients and each other", another respondent noted "prefer the ease of access to several patient areas in close proximity. I prefer the open atmosphere as opposed to closed off private rooms but i suppose in certain circumstances private rooms are much more appropriate for privacy reasons." Two more respondents noted "can prevent isolation/ loneliness. Easier to observe."; "you are able to interact with more then [sic] one patient at a time. It allows you to observe patients without feeling cut off from the rest of the ward."

Two respondents talked about the safety aspect for patients in open wards "due to working in a highly specialised unit, I would say it offers better patient safety and the ability of nurses and doctors to treat patients swiftly". One respondent chose open ward but noted that it is enjoyable in both environment "I don't have a preference I enjoy working in both." One respondent reported, "patients helped each other with morale and prevented depression". Two respondents chose open ward because of their lack of experience in single patient beds "I did not ever experience a single patient ward, but on open ward there were always other people around to assist if needed". One of the respondents claimed that open wards are better for patients not to feel lonely "people get lonely in single rooms". Another respondent argued that ward is better to see whether there was any shortage of staff "can see more easily what is happening when staff shortages are apparent. Single room patients still get infections and therefore in my opinion side rooms should be for isolation, very ill patients and palliative/care of the dying."

The following variables (HC_{users}-5-1, HC_{users}-5-2 and HC_{users}-5-3) asked for respondents' reflections of their experience of working in patient areas that are most familiar with.

Variable- HC_{users}-5-1: How well are/were the patient areas in your hospital orientated towards daylight?

The following table illustrates the frequency of responses for Variable- HC_{users}-5-1 *How well are/were the patient areas in your hospital orientated towards daylight*.

Rating	Frequency	Percent	Cumulative Percent
(1) Poor	2	4.3	4.3
(2) Fair	4	8.5	12.8
(3) Good	19	40.4	53.2
(4) Very good	14	29.8	83.0
(5) Excellent	8	17	100.0
Total	47	100.0	

Table 4.36: Interpretation of the findings for Variable- HC_{users}-5-1.

In this question, the respondents are required to show their opinions on a scale of 1 to 5 by selecting one of the following options (poor, fair, good, very good and excellent) according to their experience of working inpatient areas. The question is about the patient areas and their orientation towards the daylight. In Table 4.36, the biggest percentage lies within 'good category' with 19 respondents (40.4%), followed by fourteen respondents (29.8%) who highlighted the orientation of patient areas towards the daylight as 'very good. Eight people (17%) described the orientation towards the daylight as 'excellent'. Four people (8.5%) described it as 'fair' and 2 respondents (4.3%) described the orientation of patient areas towards the daylight as 'poor'. Fifteen respondents out of 47 gave further comments in the optional comment box regarding the orientation of the patient areas towards the daylight. Four respondents expressed their opinions, in the optional comment box that views of the building depended on its orientation with some rooms having good views and others views of brick walls; "most rooms have views but some have windows looking onto a brick wall". "All rooms have windows but some get better light than others depending on the side of the building"; "I found this varied greatly."; "we have several sites and some are better than others with regard to day light". Two other respondents noted that the building might have good daylight depending on the ward, unit or bed availability "again this depending on unit and bed availability", "depending on ward. Most bays and single rooms will have windows."

Another respondent argued that sunlight could be minimised at the ground floor levels by the proximity to other buildings and by tinted windows in other cases "tinted windows, cannot tell if it is sunny outside. At ground floor level, close proximity to other buildings also minimizes sunlight." The orientation depends on the space, most wards have windows that allow daylight, but special wards such as Intensive Care Unit 'ICU' and emergency departments have fewer windows, which does not allow daylight access as three respondents noted "Most hospitals and wards I have worked on have a lot of windows. However emergency departments and ICU tend to be darker with fewer windows."; "very good orientation as the space permits"; "Neonatal units and paediatric intensive care units had artificial lighting 24 hours as windows poor."

Four respondents claimed that some spaces might not have enough daylight due to the dignity of patients "in intensive care we did try but window etc were often blanked out for patient dignity"; "Daylight as visible but not accentuated." "Bathrooms had no natural light and many of the offices also"; "most cubicles and bays had natural daylight from large windows but 4 cubicles didn't." One respondent claimed that the building could have natural lights, "The building does have natural light so this makes it easier."

Variable- HC_{users}-5-2: How good is/was the shading in the room to minimize the adverse effects of direct sunlight and solar exposure to patients?

The following table illustrates the frequency of responses for Variable- HC_{users}-5-2 *How good is/was the shading in the room to minimize the adverse effects of direct sunlight and solar exposure to patients.*

Rating	Frequency	Percent	Cumulative Percent
(1) Poor	1	2.1	2.1
(2) Fair	6	12.8	14.9
(3) Good	16	34.0	48.9
(4) Very good	17	36.2	85.1
(5) Excellent	7	14.9	100.0
Total	47	100.0	

Table 4.37: Interpretation of the findings for Variable- HC_{users}-5-2.

This question is about the shading in the room that helps minimizing the adverse effects of direct sunlight and solar exposure to patients. In Table 4.37, the biggest percentage 36.2% lies within 'very good' category with 17 respondents, followed by 16 respondents (34%) who

described the shading in the room as 'good'. Seven respondents (14.9%) described it as 'excellent' and 6 people (12.8%) described it as 'fair', while only 1 respondent (2.1%) described the shading in the room as 'poor'.

Five respondents out of 47 gave further comments in the optional comment box regarding the shading in the room that helps in minimizing the adverse effects of direct sunlight and solar exposure to patients. Their comments are as follow: "can only draw curtains"; "windows now have shaded blinds fitted also patients on open wards are able to partially draw there [sic] privacy curtain"; "we installed blinds between 2 panes of glass which reduces cleaning etc. and infection rates"; "windows blanked out"; "depended on someone closing blinds/curtains etc. when patients could not always manage this themselves".

Variable- HC_{users}-5-3: How good are/were the artificial lights in the room?

The following table illustrates the frequency of responses for Variable- HC_{users}-5-3 *How good are/were the artificial lights in the room.*

Rating	Frequency	Percent	Cumulative Percent
(1) Poor	2	4.3	4.3
(2) Fair	9	19.1	23.4
(3) Good	12	25.5	48.9
(4) Very good	16	34.0	83.0
(5) Excellent	8	17.0	100.0
Total	47	100.0	

Table 4.38: Interpretation of the findings for Variable- HC_{users}-5-3.

This question is about the artificial lights in the room. In Table 4.38, the biggest percentage 34% lies within 'very good' category with 16 respondents, followed by 12 respondents (25.5%) who described the lights in the room as 'good'. In this question, there were 8 respondents (17%) who described the artificial lights in the room as 'excellent', 9 people (19.1%) described it as 'fair' and 2 respondents (4.3%) described it as 'poor'. Seven participants expressed their views in regards to the artificial lights in the room. Five respondents noted that the glare from the artificial lights could cause headache, when the light is too bright, it can also affect the vision and put stress on it, leading to nausea, tiredness according to patients who complained about the light. These were their comments: "The artificial lights in the room are good from a practitioner perspective but many patients

complain that they are too bright when they are laid in bed."; "Too bright, Can affect vision at times/put stress on vision." "Variable options available"; "Sometimes glare from lights can cause headache."; "Very bright, patients often complain that it impacts on how they are feeling, e.g. headache, nausea, tiredness. Can be dimmed at bedside but if other patients have light on full brightness it still affects that person." However, if the light is soft, it would help in the patient recovery, as some bedside tables have dimmer switches to soften the light as one respondent noted "Can be too harsh. Dimmer switches to soften lighten can be beneficial, particularly is patients are acutely unwell or in pain. Soft lighting can help them to feel more relaxed and are not as stimulating". Two other respondents added, "low energy is not always good for patients who have visual impairments"; "No day light lights, often dark and depressing".

The following variables (HC_{users}-6-1, HC_{users}-6-2…HC_{users}-6-23) asked for respondents' agreement in the following statements by selecting (i.e. strongly disagree, disagree, neutral, agree, and strongly agree).

Variable- HC_{users}-6-1: The design of patient areas is very important to the patient's recovery and wellbeing.

The following table illustrates the frequency of responses for Variable- HC_{users}-6-1 *the design of patient areas is very important to the patient's recovery and wellbeing*

Rating	Frequency	Percent	Cumulative Percent
(1) Strongly disagree	0	0	0
(2) Disagree	0	0	0
(3) Neutral	3	6.4	6.4
(4) Agree	16	34.0	40.4
(5) Strongly agree	28	59.6	100.0
Total	47	100.0	

Table 4.39: Interpretation of the findings for Variable- HC_{users}-6-1.

In this question, the respondents were required to show their opinions on a scale of 1 to 5 by selecting one of the following options (strongly disagree, disagree, neutral, agree and strongly agree). According to their experience of working in patient areas. The statement is about the design of patient areas and its importance to the patient's recovery and wellbeing. In Table 4.39, twenty-eight respondents (59.6%) strongly agreed on this statement and 16

people (34%) agreed, while only 3 people (6.4%) did not express their opinions by staying neutral.

Variable- HC_{users}-6-2: A small communal ward, e.g., 4 to 6 bedrooms, provides a better recovery environment than a single patient bedroom.

The following table illustrates the frequency of responses for Variable- HC_{users}-6-2 *A small communal ward, e.g., 4 to 6 bedrooms, provides a better recovery environment than a single patient bedroom.*

Rating	Frequency	Percent	Cumulative Percent
(1) Strongly disagree	2	4.3	4.3
(2) Disagree	8	17.0	21.3
(3) Neutral	21	44.7	66.0
(4) Agree	11	23.4	89.4
(5) Strongly agree	5	10.6	100.0
Total	47	100.0	

Table 4.40: Interpretation of the findings for Variable- HC_{users}-6-2.

In this statement, 21 people (44.7%) stayed neutral about the fact that a small communal ward (4 to 6 bedrooms) is better than a single patient room. Eleven people (23.4%) agreed on this statement and 8 people (17%) disagreed. There were also five people (10.6%) who disagreed and 2 people (4.3%) who strongly disagreed.

Variable- HC_{users}-6-3: Patients have enough privacy in patient areas

The following table illustrates the frequency of responses for Variable- HC_{users}-6-3 *Patients have enough privacy in patient areas.*

Rating	Frequency	Percent	Cumulative Percent
(1) Strongly disagree	9	19.1	19.1
(2) Disagree	15	31.9	51.1
(3) Neutral	12	25.5	76.6
(4) Agree	11	23.4	100.0
(5) Strongly agree	0	0	0
Total	47	100.0	

Table 4.41: Interpretation of the findings for Variable- HC_{users}-6-3.

Fifteen people (31.9%) disagreed about the statement that patients have enough privacy in patient areas and 11 people (23.4%) agreed on it. There were 12 'neutral' (25.5%) respondents and nine respondents (19.1%) who strongly disagreed.

Variable- HC_{users}-6-4: The size of doors and doorways are important to accommodate all patients' needs

The following table illustrates the frequency of responses for Variable- HC_{users}-6-4 *The size of doors and doorways are important to accommodate all patients' needs.*

Rating	Frequency	Percent	Cumulative Percent
(1) Strongly disagree	0	0	0
(2) Disagree	0	0	0
(3) Neutral	2	4.3	4.3
(4) Agree	24	51.1	55.3
(5) Strongly agree	21	44.7	100.0
Total	47	100.0	

Table 4.42: Interpretation of the findings for Variable- HC_{users}-6-4.

In Table 4.42, twenty-four respondents (51.1%) agreed on the size of doors and doorways that are important to accommodate all patients' needs and 21 people (44.7%) strongly agreed, while 2 people (4.3%) stayed neutral.

Variable- HC_{users}-6-5: Windows are large enough to allow patients to have a pleasing view

The following table illustrates the frequency of responses for Variable- HC_{users}-6-5 *Windows are large enough to allow patients to have a pleasing view.*

Rating	Frequency	Percent	Cumulative Percent
(1) Strongly disagree	2	4.3	4.3
(2) Disagree	7	14.9	19.1
(3) Neutral	13	27.7	46.8
(4) Agree	16	34.0	80.9
(5) Strongly agree	9	19.1	100.0
Total	47	100.0	

Table 4.43: Interpretation of the findings for Variable- HC_{users}-6-5.

Sixteen people (34%) agreed that windows are large enough to allow patients to have a pleasing view, followed by 13 respondents (27.7%) who stayed neutral. There were nine people (19.1%) who strongly agreed, seven people (14.9%) who disagreed and 2 respondents (4.3%) strongly disagreed.

Variable- HC_{users}-6-6: The sound insulation is sufficient

The following table illustrates the frequency of responses for Variable- HC_{users}-6-6 The sound insulation is sufficient.

Rating	Frequency	Percent	Cumulative Percent
(1) Strongly disagree	4	8.5	8.5
(2) Disagree	19	40.4	48.9
(3) Neutral	13	27.7	76.6
(4) Agree	9	19.1	95.7
(5) Strongly agree	2	4.3	100.0
Total	47	100.0	

Table 4.44: Interpretation of the findings for Variable- HC_{users}-6-6.

Nineteen respondents (40.4%) disagreed that the sound insulation is sufficient in the patient areas with, followed by 13 people (27.7%) who stayed neutral about it. Nine people (19.1%) agreed on this statement, 2 people (4.3%) strongly agreed and finally, 4 people (8.5%) strongly disagreed.

Variable- HC_{users}-6-7: The room air temperature is appropriate in the patients' areas

The following table illustrates the frequency of responses for Variable- HC_{users}-6-7 The room air temperature is appropriate in the patients' areas.

Rating	Frequency	Percent	Cumulative Percent
(1) Strongly disagree	3	6.4	6.4
(2) Disagree	10	21.3	27.7
(3) Neutral	9	19.1	46.8
(4) Agree	20	42.6	89.4
(5) Strongly agree	5	10.6	100.0
Total	47	100.0	

Table 4.45: Interpretation of the findings for Variable- HC_{users}-6-7.

Twenty respondents (42.6%) agreed that the room air temperature is appropriate in the patient areas, followed by 10 people (21.3%) who disagreed about it. Nine respondents (19.1%) stayed neutral about the statement. Finally, 5 respondents (10.6%) strongly agreed and 3 respondents (6.4%) strongly disagreed.

Variable- HC_{users}-6-8: The patient areas are of adequate size

The following table illustrates the frequency of responses for Variable- HC_{users}-6-8 The patient areas are of adequate size.

Rating	Frequency	Percent	Cumulative Percent
(1) Strongly disagree	4	8.5	8.5
(2) Disagree	8	17.0	25.5
(3) Neutral	6	12.8	38.3
(4) Agree	24	51.1	89.4
(5) Strongly agree	5	10.6	100.0
Total	47	100.0	100.0

Table 4.46: Interpretation of the findings for Variable- HC_{users}-6-8.

Twenty-four respondents (51.1%) agreed that the patient areas are of adequate size, followed by 8 people (17%) who disagreed about this statement. Six people (12.8%) stayed neutral, 5 people (10.6%) strongly agreed and 4 respondents (8.5%) strongly disagreed.

Variable- HC_{users}-6-9: The quality of the clinical furniture in the rooms, e.g., bins, chairs, lockers, etc., affects the well-being and recovery of patients.

The following table illustrates the frequency of responses for Variable- HC_{users}-6-9 The quality of the clinical furniture in the rooms, e.g., bins, chairs, lockers, etc., affects the well-being and recovery of patients.

Rating	Frequency	Percent	Cumulative Percent
(1) Strongly disagree	0	0	0
(2) Disagree	6	12.8	12.8
(3) Neutral	8	17.1	29.8
(4) Agree	28	59.6	89.4
(5) Strongly agree	5	10.6	100.0
Total	47	100.0	

Table 4.47: Interpretation of the findings for Variable- HC_{users}-6-9.

In Table 4.47, twenty-eight 28 people (59.6%) agreed that the quality of the clinical furniture in the rooms including (the bins, chairs, lockers, etc.) affects the wellbeing and recovery of patients, followed by 8 people (17.1%) who stayed neutral. There were 6 respondents (12.8%) who disagreed on this statement and 5 people (10.6%) who strongly agreed.

Variable- HC_{users}-6-10: The placement of clinical furniture is well suited to the recovery of patients and effective staff working

The following table illustrates the frequency of responses for Variable- HC_{users}-6-10 The placement of clinical furniture is well suited to the recovery of patients and effective staff working.

Rating	Frequency	Percent	Cumulative Percent
(1) Strongly disagree	0	0	0
(2) Disagree	3	6.4	6.4
(3) Neutral	19	40.4	46.8
(4) Agree	22	46.8	93.6
(5) Strongly agree	3	6.4	100.0
Total	47	100.0	

Table 4.48: Interpretation of the findings for Variable- HC_{users}-6-10.

Twenty-two people (46.8%) agreed that the placement of clinical furniture is well suited to the recovery of patients and effective staff working, while 19 people (40.4%) stayed neutral on their opinion regarding this statement. Finally, three people (6.4%) strongly agreed on this statement and 3 respondents (6.4%) disagreed.

Variable- HC_{users}-6-11: The washing facilities are well suited to the recovery of patients and staff working

The following table illustrates the frequency of responses for Variable- HC_{users}-6-11 The washing facilities are well suited to the recovery of patients and staff working.

Rating	Frequency	Percent	Cumulative Percent
(1) Strongly disagree	1	2.1	2.1
(2) Disagree	11	23.4	25.5
(3) Neutral	9	19.1	44.7
(4) Agree	21	44.7	89.4
(5) Strongly agree	5	10.6	100.0
Total	47	100.0	

Table 4.49: Interpretation of the findings for Variable- HC_{users}-6-11.

Twenty-one people (44.7%) agreed that the washing facilities are well suited to the recovery of patients and staff working, followed by 9 people (19.1%) who stayed neutral. Eleven respondents (23.4%) disagreed on this statement, 5 people (10.6%) strongly agreed that the

washing facilities are well suited to the recovery of patients and staff working and only 1 person (2.1%) strongly disagreed.

Variable- HC_{users}-6-12: Electric points are well suited to the recovery of patients and staff working

The following table illustrates the frequency of responses for Variable- HC_{users}-6-12 Electric points are well suited to the recovery of patients and staff working.

Rating	Frequency	Percent	Cumulative Percent
(1) Strongly disagree	1	2.1	2.1
(2) Disagree	7	14.9	17.0
(3) Neutral	8	17.0	34.0
(4) Agree	27	57.4	91.5
(5) Strongly agree	4	8.5	100.0
Total	47	100.0	

Table 4.50: Interpretation of the findings for Variable- HC_{users}-6-12.

Twenty-seven people (57.4%) agreed that the electric points are well suited to the recovery of patients and staff working and 8 people (17%) stayed neutral, while 7 disagreed (14.9%) on this statement. Finally, four respondents (8.5%) strongly agreed and only 1 respondent (2.1%) strongly disagreed on the statement.

Variable- HC_{users}-6-13: Window blinds are well suited to the recovery of patients and staff working

The following table illustrates the frequency of responses for Variable- HC_{users}-6-13 Window blinds are well suited to the recovery of patients and staff working.

Rating	Frequency	Percent	Cumulative Percent
(1) Strongly disagree	1	2.1	2.1
(2) Disagree	6	12.8	14.9
(3) Neutral	17	36.2	51.1
(4) Agree	20	42.6	93.6
(5) Strongly agree	3	6.4	100.0
Total	47	100.0	

Table 4.51: Interpretation of the findings for Variable- HC_{users}-6-13.

Twenty people (42.6%) agreed that the window blinds are well suited to the recovery of patients and staff working and 17 people (36.2%) stayed neutral. Six people (12.8%)

disagreed on this statement, one respondent (2.1%) strongly disagreed on the statement and 3 respondents (6.4%) strongly agreed.

Variable- HC_{users}-6-14: Equipment storage rooms are well suited to the recovery of patients and staff working

The following table illustrates the frequency of responses for Variable- HC_{users}-6-14 Equipment storage rooms are well suited to the recovery of patients and staff working.

Rating	Frequency	Percent	Cumulative Percent
(1) Strongly disagree	3	6.4	6.4
(2) Disagree	11	23.4	29.8
(3) Neutral	9	19.1	48.9
(4) Agree	23	48.9	97.9
(5) Strongly agree	1	2.1	100
Total	47	100.0	

Table 4.52: Interpretation of the findings for Variable- HC_{users}-6-14.

Twenty-three people (48.9%) agreed that the equipment storage rooms are well suited to the recovery of patients and staff working. Eleven people (23.4%) disagreed, 9 respondents (19.1%) stayed neutral and 3 people (6.4%) strongly disagreed with 1 respondent (2.1%) who agreed on the statement.

Variable- HC_{users}-6-15: The sightline from the doctors' and nurses' stations to the patients is adequate

The following table illustrates the frequency of responses for Variable- HC_{users}-6-15 *The sightline from the doctors' and nurses' stations to the patients is adequate.*

Rating	Frequency	Percent	Cumulative Percent
(1) Strongly disagree	5	10.6	10.6
(2) Disagree	14	29.8	40.4
(3) Neutral	15	31.9	72.3
(4) Agree	9	19.1	91.5
(5) Strongly agree	4	8.5	100.0
Total	47	100.0	100.0

Table 4.53: Interpretation of the findings for Variable- HC_{users}-6-15.

In this statement, 15 people (31.9%) stayed neutral, while 14 respondents (29.8%) disagreed. Nine people (19.1%) agreed, five people (10.6%) strongly disagreed, and four respondents (8.5%) strongly agreed.

Variable- HC_{users}-6-16: The visibility from the corridor to the patient rooms helps with patients' recovery

The following table illustrates the frequency of responses for Variable- HC_{users}-6-16 *The visibility from the corridor to the patient rooms helps with patients' recovery.*

Rating	Frequency	Percent	Cumulative Percent
(1) Strongly disagree	1	2.1	2.1
(2) Disagree	8	17.0	19.1
(3) Neutral	12	25.5	44.7
(4) Agree	25	53.2	97.9
(5) Strongly agree	1	2.1	100.0
Total	47	100.0	

Table 4.54: Interpretation of the findings for Variable- HC_{users}-6-16.

In this statement, twenty-five people (53.2%) agreed that the visibility from the corridor to the patient rooms helps with patients' recovery, followed by 12 people (25.5%) who stayed neutral and eight people (17%) disagreed on this statement. There were one respondent (2.1%) in each category 'strongly agree' and 'strongly disagree'.

Variable- HC_{users}-6-17: The patients' dignity and privacy are maintained

The following table illustrates the frequency of responses for Variable- HC_{users}-6-17 The patients' dignity and privacy are maintained.

Rating	Frequency	Percent	Cumulative Percent
(1) Strongly disagree	2	4.3	4.3
(2) Disagree	4	8.5	12.8
(3) Neutral	10	21.3	34.0
(4) Agree	24	51.1	85.1
(5) Strongly agree	7	14.9	100.0
Total	47	100.0	

Table 4.55: Interpretation of the findings for Variable- HC_{users}-6-17.

In Table 4.55, twenty-four people (51.1%) agreed that the patients' dignity and privacy are maintained in the wards. Ten people (21.3%) stayed neutral and seven respondents (14.9%)

strongly agreed. There were four people (8.5%), who disagreed on this statement and two people (4.3%) strongly disagreed.

Variable- HC_{users}-6-18: The size of showers is sufficient to support the patients' recovery

The following table illustrates the frequency of responses for Variable- HC_{users}-6-18 The size of showers is sufficient to support the patients' recovery.

Rating	Frequency	Percent	Cumulative Percent
(1) Strongly disagree	2	4.3	4.3
(2) Disagree	4	8.5	12.8
(3) Neutral	11	23.4	36.2
(4) Agree	23	48.9	85.1
(5) Strongly agree	7	14.9	100.0
Total	47	100.0	

Table 4.56: Interpretation of the findings for Variable- HC_{users}-6-18.

In Table 4.56, twenty-three people (48.9%) agreed that the size of showers is sufficient to support the patients' recovery, followed by 11 people (23.4%) who stayed neutral on this statement. Finally, seven people (14.9%) strongly agreed, four respondents (8.5%) disagreed on this statement and 2 respondents (4.3%) strongly disagreed.

Variable- HC_{users}-6-19: Bathrooms' size is big enough for patient's recovery

The following table illustrates the frequency of responses for Variable- HC_{users}-6-19 Bathrooms' size is big enough for patient's recovery.

Rating	Frequency	Percent	Cumulative Percent
(1) Strongly disagree	2	4.3	4.3
(2) Disagree	5	10.6	14.9
(3) Neutral	12	25.5	40.4
(4) Agree	22	46.8	87.2
(5) Strongly agree	6	12.8	100.0
Total	47	100.0	

Table 4.57: Interpretation of the findings for Variable- HC_{users}-6-19.

In table 4.57, twenty-two people (46.8%) agreed that the bathrooms' size are big enough for the patients' recovery, followed by 12 people (25.5%) who stayed neutral on this statement.

Six respondents (12.8%) strongly agreed, five respondents (10.6%) disagreed and 2 people (4.3%) strongly disagreed.

Variable- HC_{users}-6-20: The patients' bedrooms size is sufficiently large to support recovery

The following table illustrates the frequency of responses for Variable- HC_{users}-6-20 The patients' bedrooms size is sufficiently large to support recovery.

Rating	Frequency	Percent	Cumulative Percent
(1) Strongly disagree	0	0	0
(2) Disagree	6	12.8	12.8
(3) Neutral	9	19.1	31.9
(4) Agree	26	55.3	87.2
(5) Strongly agree	6	12.8	100.0
Total	47	100.0	

Table 4.58: Interpretation of the findings for Variable- HC_{users}-6-20.

In Table 4.58, twenty-six people (55.3%) agreed that the patients' bedrooms size is sufficiently large to support recovery of patients, followed by 9 people (19.1%) who stayed neutral, 6 people (12.8%) disagreed on this statement and 6 others (12.8%) strongly agreed.

Variable- HC_{users}-6-21: Visitors have enough space to visit patients in their room

The following table illustrates the frequency of responses for Variable- HC_{users}-6-21 Visitors have enough space to visit patients in their room.

Rating	Frequency	Percent	Cumulative Percent
(1) Strongly disagree	3	6.4	6.4
(2) Disagree	13	27.7	34.0
(3) Neutral	4	8.5	42.6
(4) Agree	24	51.1	93.6
(5) Strongly agree	3	6.4	100.0
Total	47	100.0	

Table 4.59: Interpretation of the findings for Variable- HC_{users}-6-21.

In this statement, 24 people (51.1%) agreed that the visitors have enough space to visit patients in their rooms, followed by 13 people (27.7%) who disagreed on this statement. There were 3 people (6.4%) in each category (strongly disagree and neutral) and 4 respondents (8.5%) who stayed neutral.

Variable- HC_{users}-6-22: Communal space is well equipped and designed for patients' recovery

The following table illustrates the frequency of responses for Variable- HC_{users}-6-22 Communal space is well equipped and designed for patients' recovery.

Rating	Frequency	Percent	Cumulative Percent
(1) Strongly disagree	3	6.4	6.4
(2) Disagree	10	21.3	27.7
(3) Neutral	17	36.2	63.8
(4) Agree	15	31.9	95.7
(5) Strongly agree	2	4.3	100.0
Total	47	100.0	

Table 4.60: Interpretation of the findings for Variable- HC_{users}-6-22.

In Table 4.60, seventeen people (36.2%) stayed neutral about the fact that the communal space is well-equipped and designed for patients' recovery, followed by 15 people (31.9%) who agreed. Ten people (21.3%) disagree on this statement, three respondents (6.4%) strongly disagreed about it and 2 others (4.3%) strongly agreed.

Variable- HC_{users}-6-23: The circulation areas are conducive to the recovery of patients

The following table illustrates the frequency of responses for Variable- HC_{users}-6-23 The circulation areas are conducive to the recovery of patients

Rating	Frequency	Percent	Cumulative Percent
(1) Strongly disagree	1	2.1	2.1
(2) Disagree	6	12.8	14.9
(3) Neutral	25	53.2	68.1
(4) Agree	12	25.5	93.6
(5) Strongly agree	3	6.4	100.0
Total	47	100.0	

Table 4.61: Interpretation of the findings for Variable- HC_{users}-6-23.

In Table 4.61, twenty-five people (53.2%) stayed neutral on the statement that the circulation areas are conducive to the recovery of patients. Twelve people (25.5%) agreed on this statement, six people (12.8%) disagreed and three people (6.4%) strongly agreed with one respondent (2.1%) who strongly disagreed.

Variable- HC_{users}-7-1: Which room layout, would be beneficial or helps you more in your day-to-day task?

The following table illustrates the frequency of responses for Variable- HC_{users}-7-1 *Which room layout, would be beneficial or helps you more in your day-to-day task?*

Type of Ward	Frequency	Percent	Cumulative Percent
Same handed rooms or mirrored rooms	22	46.8	46.8
Inboard toilet rooms	16	34.0	80.9
Outboard toilet rooms	4	8.5	89.4
Nested toilet rooms	5	10.6	100.0
Total	47	100.0	

Table 4.62: Interpretation of the findings for Variable- HC_{users}-7-1.

In this question, participants were given a definition of all room layouts prior to the list of options where 22 (46.8%) respondents out of 47 preferred to work in a same-handed room or mirrored room followed by 16 people (34%) who preferred inboard toilet room. The following category is 'outboard toilet room' chosen by four people (8.5%) and five people (10.6%) selected nested toilet room.

Two participants out of 22 specified the reasons of their choice in terms of 'same-handed room'; as they said it is better to have the same room layout so that staff, patients and their visitors are familiar with the place. In addition to the fact that it minimises risk of getting lost as noted in their comments "Consistency minimises risk to patients and staff and ensure that everyone knows where things are."; "Reduces time need to familiarise yourself with a new area." Two other participants added "less time spent trying to find essential equipment required to potentially save a patients [sic] life patient-and staff from different wards will be familiar to said equipment ...."; "easier for staff especially students and new staff".

Three out of 16 respondents explained the reason of choosing 'inboard toilet rooms' by stating that it enables views, more daylight and a good acoustic isolation "views, less acoustic disturbance and maximum daylight for positive experience and safety via visibility"; "Daylight and staff visibility"; "acoustic separation". Three more participants said that it allows more privacy "allows most privacy"; "additional space is good for moving and handling, assessing transfers. Offers privacy." One respondent added, "Single bathrooms

means isolation/infection control managed easier." One participant out of 4 respondents justified the choice of 'outboard toilet room' by stating "patient access and visibility for those most critical patients who may require more monitoring and care".

Four participants out of 5 respondents provided more comments about their choice 'nested toilet rooms' by stating that patients can benefit from daylight and scenery as well as the variety of option in room layout as it would result in one outboard room and one inboard room. These comments were "patients can benefit from daylight & scenery whilst at the same time staff being able to see into patient room without difficulty."; "Creates two options"; "Priorities for patients change during a stay, for patients receiving palliative care where close observation is less pertinent would benefit more from privacy and views. The critically unwell patient needs to be visible and therefore an outboard toilet would be more suitable. Having nested toilets would allow you to facilitate both but that would need to be clear in the use of the ward as may become a nuisance if patients are not allocated bed spaces appropriately"; "Staff could decide which patients is best to access either an in or outboard toilet".

Variable- HC_{users}-7-2: Participants who opted for more than one layout of the room

The following table illustrates the frequency of responses for Variable- HC_{users}-7-2 Participants who opted for more than one layout of the room.

	Frequency	Percent	Valid Percent	Cumulative Percent
Respondent: Inboard toilet rooms	3	6.4	60.0	60.0
Respondent: Outboard toilet rooms	1	2.1	20.0	80.0
Respondent: Nested toilet rooms	1	2.1	20.0	100.0
Total	5	10.6	100.0	
Missing	42	89.4		
Total	47	100.0		

Table 4.63: Interpretation of the findings for Variable- HC_{users}-7-2.

The table demonstrates that 5 respondents out of 47 selected more than one option in regards to the room layouts, as 3 people chose ‘inboard toilet rooms’, 1 respondent chose ‘outboard toilet room’ and 1 respondent chose ‘nested toilet rooms’.

The respondents who selected ‘inboard toilet rooms’ selected another option ‘same-handed rooms’ and one of them noted “Provides a larger space for visitors.” One respondent selected ‘outboard toilet rooms’ and ‘same-handed rooms’. One respondent chose two options ‘nested toilet rooms’ and ‘same-handed rooms’ and noted “If rooms alternate, you could select the most appropriate room for you patient. Some may find mobilising easier to one side.”

Three open-ended questions were asked in regards to the space availability, and the additional spaces healthcare’ users need. These were:

A. Do you have enough spaces for lunchrooms, meeting rooms, rest areas, or relaxing rooms?
B. What other spaces do you think are important for you and patients?
C. What other spaces do you think are important to support patients?

For question (A), 20 participants were satisfied with the spaces provided on ward by responding with yes as one of them noted, “Yes, the vast majority of resting rooms are ideal. Meeting rooms could be improved”. While thirteen people were not satisfied by responding with no, were 9 respondents justified their answers as follow:
“Not sufficient, but realistically it is probably adequate.” “No, most of these have been removed” “no staff often changed in the toilets” “No, well some do some don't- it depends on the ward. Also your above questions, I could have answered several boxes for different wards I have worked on, there is vast variation, even within one hospital.” “NO No day rooms now for patients on medium to long stay wards” “no because space is limited , usually there would not be enough space, and if there was, it would be assigned for something else at some point” “no - limited space in canteen, no designated spaces for staff/patients, no staff tea-room” “Not at all. There are very few staff rooms and the ones that exist are small and poorly equipped. I also know that nursing staff do not have enough changing room space” “Disagree”. Fourteen respondents extended their answers with comments such as, i.e. the spaces are limited and poorly designed, not enough changing rooms for staff and the meeting rooms could be improved. Their comments are as follow: “most wards did not have suitable areas” “This depends on the ward. Some have very good family/meeting rooms, whereas others do not. Doctors' office size and layout can also be

quite variable." "1 small day room" "Varies depending on ward" "Tend not to be on wards, have to go elsewhere e.g. canteen" "Minimal space that is poorly designed." "Canteen could be bigger, would enable more seating and bigger choice of food on offer." "MDT 'multidisciplinary team' rooms are scarce Communal rooms for patients when present are underused" "we had a staff canteen for all...no rest, relaxation rooms in my day" "rooms exist, but too small".

For question (B), 40 participants noted that the spaces that are important for both staff and patients include outdoor spaces, rehabilitation and therapy, play areas, quiet rooms to have private discussion, kitchens and offices. Eight respondents noted that waiting areas are one of the spaces that could be taken into consideration as well as garden and outdoor spaces. Their comments are as follow "outdoor space", "seating/waiting areas" "Garden area, outside seating.", "outside sitting, area private area to have conversations that are not overheard", "an accessible outside garden area with suitable seating" "An accessible outside garden area with suitable seating" "dayrooms/outdoor space where possible." Furthermore, therapy and dayrooms are another important space in the ward "Designated therapy room with appropriate equipment." "Therapy room Social/day room" "Play therapy" "Places to go for therapy- assessment areas." "Day rooms" added four respondents. Private areas for patients like communal spaces and kitchen "privacy room [for relatives to speak in private, with loved ones/ medical staff alike... multi- faith [sic] rooms...kitchen/dinning [sic] area..." "Family rooms for private discussions." "Quiet rooms, social rooms for relatives to talk to their loved ones in peace" "communal area, toilet", "communal areas for patients Areas to work for staff close enough to patient rooms but spacious enough to be able to work." "Patients kitchen. So they can make their own cup of tea etc." "Good communal areas away from staff" "It would be nice to have more space for patients to move around to. Maybe a communal room for them to walk to for coffee. This would give them somewhere to aim to when walking about the ward and encourage them to mobilise instead of just sitting by their bed all day" "I think proper kitchens would be really helpful for patients and their families, especially in long term care facilities." Plays areas for kids "Playrooms - children.", "play areas with age appropriate equipment - teenage areas - parent/visitors room".

It has been clear from the comments that there is a lack of offices, restrooms and showers for staff on ward as 3 respondents noted "Office space so we don't have to work in the corridor which tends to get in the way of patients who are having physio etc." "Office room"

“Doctors' offices, changing rooms, cafeterias.” Six people added “Office space for drs ‘doctors’ often overlooked”, “showers for staff restrooms that are private and not directly accessible by patients”, “Sufficient areas for staff to work” “Call room”, “areas for private conversations that are not offices” “space just for staff but not off the ward so staff can eat meals without being too far away should there be any clinical issues.” Two respondents added rehabilitation areas and physiotherapy spaces “rehab area”, “Physio- space to walk - areas to meet off the ward with friends and relative”. In addition to other comments noted by 5 other respondents “Having both a sink for ablutions BUT this sink is not for hand hygiene” “Bathrooms with actual bath in (only showers on ward)” “Actual wards and all other communal areas of the hospital” “Enough room to walk around” “Mobil phones area”.

For question (C), 35 participants expressed their views as to the additional spaces that could support patients; these include social areas for patients as noted by 5 respondents “Social spaces for patients.”, “family rooms gardens/scenic rooms/quiet rooms” “Common room”, “Family rooms appropriate for children visiting” “Day-rooms, pleasant outdoors [sic] environment for walks if needed.” Three other respondents added “A day room where they can spend time a private room for important discussions with patient and family away from the bay and other people” “communal lounge area for long stay wards” “Small quiet areas to meet visitors or talk to professionals in a more private area”. A space designed for dining areas and a kitchen for patients as claimed by 4 participants “Provision of kitchen and dining areas so patients can help themselves to food at anytime night or day. Meal times are not always in keeping with the patients’ routine and are for the convenience of the hospital/ward routine.” “Patients kitchen, patients’ salon.”, “kitchen facilities”, “Dining area”. In addition to quiet areas as noted by 2 respondents “Small quiet areas to meet visitors or talk to professionals in a more private area.” “Places to go with family, its [sic] very difficult when confined to a small room/ bed area.”

Three respondents added comments about spaces that should be reserved for visitors “visitor spaces with drink facilities” “specialist bereavement .... quite [sic] room... sufficient space between each cubical...allowing total privacy whilst talking to others or resting.....room where patients can buy essentials....”, “parents facilities.” Five respondents added “quiet rooms” “Quiet rooms” “an outdoor area” “Playrooms” “large play and family rooms, spaces for parents to be away from children, quiet rooms that can be about reading a paper and mindfulness not just used as spaces for breaking bad news.” “Somewhere quiet with no TV”.

Outdoor spaces with relaxing areas as noted by 4 participants “outside sitting area quiet area” “More relaxing areas” “Nice garden areas and windows that open” “outside sitting area quiet area garden”. More rooms for staff as 2 respondents added “Recreational room”, “staff rooms”. “Space for rehabilitation/physio” “Recovery room” “Wards/ shower/WC faculties and also hospital grounds” “Large bathrooms” added four respondents. One of the respondents was satisfied with the quality of the ward as claimed “None; a lot of effort has been taken to get maximum use from all available areas in the general hospital environment where I work.”

4.3 SUMMARY

This chapter has discussed the analysis and findings of the data collected from the questionnaires, starting with a descriptive analysis of the responses. This was followed by a thematic analysis of the open questions where themes and codes were retrieved that eventually help in answering the research question and developing the framework as well as the first part of the contribution of the research. The findings of the healthcare survey were then presented, which helped in the development of the second part of the contribution of the research and the answer to the research question. The next chapter will present the interviews and their analysis.

CHAPTER FIVE

5 ANALYSIS OF SEMI-STRUCTURED INTERVIEWS WITH DESIGNERS

5.0 INTRODUCTION

The previous chapter presented the data collection and results of the Designers and Healthcare surveys. This current chapter analyses the data collected from the semi-structured interviews that help to shed light on the findings of the previous survey data. Fourteen interviews were conducted over a period of one month. The interviewees were from different locations in the UK, including Newcastle, London, Leeds and Glasgow. The interview time was between 38 min and 2 hours depending on each interviewee, their knowledge and availability. The interviews were transcribed in MS Word by listening to the recordings. Then they were transferred to NVivo for further analysis. They were then analyzed by using a content analysis. Each question was analyzed separately, according to interviewees' responses, summarized and supported with their quotes. During the analysis, the researcher did a back-and-forth between transcriptions and recordings as it was necessary to re-listen to them for confirmation. NVivo helped in structuring and classifying the data, as the transcriptions were exported to MS Word for the analysis. The interviewees were asked 27 questions, divided in 7 sections (see Appendix 2). The sections were:

- General importance of users-feedback, their capture and reuse
- What feedback? How? When? Priority?
- What does not work?
- What is the process of using feedback?
- What is explicit, tacit, pattern language?
- Could tacit knowledge be explicit (e.g. knowledge repository)?
- Optional questions

The overall number of respondents who accepted the follow-up interview after the survey were 14 and these are referred to in the following sections as 'Interviewee 1, Interviewee 2…Interviewee 14'. All the interviewees were designers experienced in the healthcare sector and working in architectural practices that design for private and public sector. The sections were presented in four headings then the chapter concludes with a summary that summarises

the chapter content and introduces the next chapter content. The table below illustrates a roadmap of how the analysis was done.

Interviews questions	Category subsection
A/General importance	The importance of users-feedback, their capture and reuse
B/What feedback? How? When? Priority?	
C/What does not work?	
D/What is the process of using feedback?	
E/What is explicit, tacit, pattern language?	Technology applications in transforming tacit knowledge
F/Could tacit knowledge be explicit (e.g. knowledge repository)?	
G/Optional questions	Ward-related spaces and their issues
	Privacy versus observation on wards

Table 5.1: Roadmap of interviews' analysis.

5.1 THE IMPORTANCE OF USERS-FEEDBACK, THEIR CAPTURE AND REUSE

A/ GENERAL IMPORTANCE

Designers were first asked about users-feedback and their importance in the design of wards as well as the importance of each category of users. All Designers emphasised the importance of feedback given by healthcare users (the medical and nursing staff, patients and visitors) and facility managers 'FM' users. Designers agreed that all of the categories are important to get feedback from, because they have different opinions and perspectives of seeing the environment and using it. The medical and nursing staff know how the building operates inside, which is why their views are vital and necessary in the design, by creating a good and balanced environment, it will help them in performing well; hence the patient will recover quickly. Facility managers 'FM' are also important because they help in the maintenance of the building, and the avoidance of repeating same mistakes through the lessons learnt from their projects. However, nine interviewees out of 14 said that the most important category to get feedback from is the medical staff because they use the building on a daily basis and they know the relationship between all departments, in addition to the

building functions. This statement was supported by quotes of 8 interviewees that are as follows:

> "All users are important; obviously the most important for me is the clinical staff (users) then patients then FM." (Interviewee 1).
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> "From medical and nursing staff it is how they operate when getting into that building to see how the building is designed properly and help them in their job. From FM, it's important because of the maintenance and the building lifecycle. But the most important I would say clinicians and medical staff" (Interviewee 2).
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> "it's important because of all different things, because quite often you will get clinical led design or mistakes led design and you need to go all through these stuff to understand but sometimes you don't get that feedback until after it's built, you would say if I have done that or this but you can't cause it's already done…I think the clinical outcomes is probably the most important because that is a very specific thing, because if their environment is good, their performance is good and the patient is happy and recovers quickly" (Interviewee 4).
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> "It's predominantly from hospital staff, some wards may need additional treatment rooms, we don't get feedback from patients… medical staff get us most important feedback" (Interviewee 6).
>
> "The most useful is from clinical staff because that informs the relationships and how the building functions operationally. Patient feedback comes later in the process, and they say how they feel. Mostly driven from clinical staff, and FM which all of that will get fed back into design process. Clinicians are more important because they take on board the patient's feedback" (Interviewee 7).
>
> "I think it is essential. It is one of the important things or you are going to repeat mistakes. If you don't get feedback there will be mistakes, and try to get a balance between them. So we get different feedback from different groups. From my personal point of view, I would say the medical side. Because patients are there for a short time but the medical staff are there on a daily basis and use the space for a long term. So we have to get a correct on the medical side first" (Interviewee 9).
>
> "Yes. All of them, it's a mixture because its valuable, and it's very interesting to get different perspectives of the environment and work place, they can offer positive and negative view points of those different perspectives so the broader the information we can collect the more beneficial it is. Not only POE but the briefing as well, we often interview patient groups and the estates we get their opinions of the previous projects

so we can have an idea. All of them are important, but if I had to select one would be the clinical users" (Interviewee 10).

"Yes, I would assume from the clinical function, the FM function and how it keeps it clean, and the users from the patients and visitors by extension. The aspects of feedback can be broken between all of them and each has a different perspective" (Interviewee 11).

Interviewee 11 had a new question followed up from the previous question about the difference of each category where he said that all of the categories are important and complement each other as they can retrieve walk distances and footfall from the clinical team, how to clean the space from the FM and the wellbeing from patients "the clinical function could be anything from footfalls, distance to walk, being actually able to fulfil your gaps in a more efficient way. From FM how they try to keep the space clean, from the patient side, they just want to be well, all of those might not be the same but they complete each other".

However, two interviewees said that it is important to have a balance between all of the users, as all of them see the environment differently and it is important to create a good environment for all users.

"I would say, if you get feedback from all of them, you need to get a balanced approach, to create a great environment if you create a healthcare acquired infection because you created an environment not fit for purpose and make people ill therefore it's not going to fulfil its function, then you need to moderate the feedback. There is no priority for the categories you need to make a space fit for medical purpose and all of their feedback is important" (Interviewee 11).

"Yes. All of them are equally important. Priority could be patient and staff but still FM are important to get feedback from in terms of maintaining the space."(Interviewee 13).

Five interviewees said that, the feedback is important from all of the categories, because they all have different perspectives, and it is difficult to separate their opinions or prioritise them. Their statement was supported by the following quotes:

"All of them, it's a mix of patients and staff mainly nurses because they are more than doctors since they are there all the time. They have different perspectives and views we like to hear from all of them" (Interviewee 3).

"It is important to get feedback, sometimes the client gives us a brief and sometimes it lacks information. We have sometimes negative feedback on brief. I think equally, you get different answers from each category" (Interviewee 5).

"I think three of them…it is difficult to separate because they are all important…" (Interviewee 8).

"All of the above, all of them are important, it's vital. It is part of the design process, to see all of them. We see patient group as well" (Interviewee 12).

"Of course, it is important. I think every single group has a type of feedback so it's important to have feedback from all of them." (Interviewee 14).

Five designers emphasised that feedback should be received from all of the users. They said that it is not easy to get that feedback from patients and visitors as stated by the interviewee 14 "The patient is important but we do not get feedback from them." This could be due to ethical reasons and confidentiality restrictions; yet even, they achieve the feedback, this would be missed, as it might take longer to get, and eventually not used in the design due to time constraint.

This statement was supported by interviewee 8 "The difficulty to seek feedback from patient, and visitors would be timescale if it's a short period of time being able to get feedback it could be missed. Feedback is important but difficult to get from staff and FM, staff live and work in that environment so it is important to get feedback from them and to understand what the key elements are about that feedback."

His discussion led the researcher to ask a new question about the kind of data they are looking for, and he responded that they look for the technical side of the data as well as data matrix, length of stay, infection control. In addition to other factors such as, functionality of the ward in terms of falls and trips, travel distances, and he added that POE is the most convenient tool to get all of these data. His comment was as follows:

"So, we seek the feedback from a technical point of view, we look at data matrix, length of stay, infection control rate, how often is an isolation room is used? More functional wards slip trips and falls, distances and travel time in the ward, sometimes it's POE to get the data from" (Interviewee 8).

He also added

"…the hardest, I think would be patient and visitors, it's not easy to get feedback from them because we are restricted in terms of access to them in terms of

confidentiality. But the FM is much easier to get, we need to identify the starting project and with them we get the lessons learnt from their previous projects. So with the lessons learnt we won't repeat same mistakes and we will improve the quality of the space, flooring, washing basins, we can get feedback from FM they may help us in terms of maintenance." (Interviewee 8)

Designers pointed out that feedback is necessary from all categories, starting from the medical and nursing staff, followed by facility managers, then patients and visitors, which unfortunately they do not get consistent feedback from them all the time. As for FM, they might not be involved at the early stages of the design process as stated by two interviewees:

"From FM they don't get involved early enough, they are part of the team they make general comments" (Interviewee 6).

"We get to talk to FM but not too much really" (Interviewee 2).

Interviewee 4 added that not involving FM at early stages of design might lead to missing feedback:

"Because quite often you will get clinical led design or mistakes led design and you need to go all through these stuff to understand but sometimes you don't get that feedback until after it's built, you would say if I have done that or this but you can't cause it's already done." (Interviewee 4)

Despite the importance of feedback received from FM, one designer explained that it could be conflicting to have it sometimes, because their feedback keep changing throughout the design process during the meetings, and this may contradict the design guidelines as explained:

"When we do POE, we do it first with FM then to staff and patients, but high level first, since you need to maintain the design, but if we hear FM so much the floor won't be the same because they will change it every now and then, and there will be conflicts with the guidelines. Staff may have different views to consultants and surgeons, different views depending on the services and speciality; that's why the feedback is important because what they do in that trust or what they have done may vary" (Interviewee 12).

One of the designers pointed out that all users should be involved to share their feedback; however, because they cannot capture feedback, as it is not received all the time. Therefore, it is impossible for them to build a meticulous and rigorous feedback input for future projects as stated:

"Everybody needs to give feedback in some form or another; and we don't

necessarily capture that all the time, we don't get it; therefore we can't create a thorough and robust feedback for the next building" (Interviewee 1).

Regarding patients, they may not be in a state to give feedback as Interviewee 13 stated "we prefer to have a pre-evaluation before the design process including the FM and medical staff; we don't include patients' feedback in the design process". Her answer was followed-up by another question about the kind of challenges they do not get feedback for, as she responded by saying cost is a challenge for receiving feedback. Another interviewee added

"...I think mainly the medical staff are more important because they have to deliver their services and their aim is to make the patients well, but equally the patients are there to be treated and I don't think they are able to give feedback" (Interviewee 1).

Interviewee 1 was asked following her answer about the feedback and the way patients would give it to them. She responded that they might not know, as patients need to be vocal and focused to give the feedback; however, they are discharged without giving feedback. Her comment was as follows:

"I don't think they know, they have to be vocal and focused to be able to give feedback, because most people are happy for them to be discharged without giving feedback" (Interviewee 1).

Despite the difficulty to get feedback of patients, one of the designers stated that sometimes they involve patients' representative groups in the design process who talk on behalf of patients.

"We had occasions to talk to representatives from the patient group. Patient representatives are always present in the meeting, it's helpful but usually you have to guide them a lot to get what you want from them, they give you abstract and you have to narrow it down…mainly from the clinician staff, followed by FM then patients and visitors" (Interviewee 2).

B/ WHAT FEEDBACK? HOW? WHEN? PRIORITY?

Designers were then asked about the most important criterion in the design of inpatient areas in the ward. Two designers said that the functionality of the space is important, in addition to the room aspect, as it would be great if the room was looking less clinical. This was supported by quotes of 2 interviewees as follows:

"It would be functionality of the space; from patient point of view what would like to do tend to be different, it would be better if the room would look less clinical for

them" (Interviewee 6).

"The important thing in design of in-patient wards is to function properly and make it as a relaxed comfortable environment for the patients and also for the staff, it's not only one single thing, you need to bring all of it because the patients and the staff are spending most of their time in there" (Interviewee 4).

In addition to the comfort side as added by two interviewees:

"Comfort, how it feels, patients can be different" (Interviewee 7)

"So the space should be a comfortable space" Interviewee 14).

Other factors that need to be taken into consideration in the design of wards were added by 2 interviewees that are length of stay on wards, privacy, dignity, observation, and infection control. Their quotes are as follows:

"There are two sides of that data, length of stay, infection control, generally we get negative feedback for single patient rooms from staff and families, in terms of design we refer to HBNs 'Health Building notes', HTMs 'Health Technical Memoranda', you need to confirm they have enough storage" (Interviewee 12).

"Privacy is the major one, you can quite easily get floor on a ward. How you manage the privacy aspect, it's critical and you need to do a balance between both sides" (Interviewee 9).

Other criteria have been noted by 2 interviewees that are daylights, patients' safety, access to staff and views outside, visibility, travel distances and room layout. Their quotes are as follows:

"Daylights obviously, privacy and dignity, patients feeling safe and able to get in touch with the staff when they need them. Access to views outside, being able for the nursing staff to observe the patients without having to open the door necessarily" (Interviewee 2).

"Layout, patient safety, access to natural daylight. Make sure you have adequate spaces for the family. Visibility for staff to be able to monitor the patient. Environmental factors, safety, distances. If you have a standard room, it is standardized. The design needs to support a flow of the functional spaces and the management as well" (Interviewee 13).

Interviewee 8 pointed out that the design needs to be efficient, to facilitate the work of healthcare team in treating patients. This could be through natural lights, natural ventilation, access to bathrooms as well as spaces for staff and changing facilities.

"From the HC perspective, the key is to assist clinical teams help people to get better, the efficiency that the service provides, natural light, natural ventilation, access to bathrooms, privacy and dignity, safety aspect, staff rooms, changing facilities for staff, break rooms" (Interviewee 8).

One of the designers also mentioned that from designers' point of view, the quality of the space and environment are both important factors in the design while having a refreshing and new building for users.

"I would think from the quality of space and the quality of environment, I think it is important from a designer point of view because that can impact upon the well-being and in fact can contribute to many other things. I think the as-built physical environment is important. From the users' point of view, I think they want the building to be refreshed and renewed, it depends how old he is" (Interviewee 11).

Indeed patients do not give feedback all the time and this does not help designers, as one of the designers 'Interviwee1' was hospitalised and shared her experience in the interview. The problem she noted that although she was keen to give feedback, it did not go anywhere, and this means, there was a problem of management. She said that the problems in the ward were related to the environment, the facilities, conditions and the staff management, as nobody was in on the weekend, which made patient struggling. Her quote was as follows:

"I still think the most important criterion is the clinical area, the medical staff got to be able to deliver the services because otherwise there is no point in having the design. The staff work in a particular space and patients also need to give feedback because many of them get to be unhappy and frightened at times in hospital wards, so we need to find that. However, I think again that it is insufficient because patients leave without giving feedback. Interestingly, I was an in-patient myself and gave feedback and I know it went absolutely nowhere, I was critical of what I saw, it was critical. I saw many mistakes and things that were wrong from FM side, clinical side and patient side. I know my feedback wasn't gone anywhere; I heard that patients use a form called PALS 'patient advice and liaison service' to put feedback in but it goes nowhere. I wrote many letters to give feedback regarding the ward but nobody got back to me, it was about environment, facilities, condition and staffing. The medical staff struggled because there was nobody on the weekend and patients suffered from my point of view which made me angry" (Interviewee 1).

One of the designers added another criterion that is wayfinding, as users may get lost in the ward, besides the area size, lights in the corridors and clinically insured such as medical

gases. He also shared his thoughts about single patient rooms that is differently designed, and viewed from different perspectives in different countries.

He also added that it is a good option because of the recovery time and the possibility of cleaning as the multi bed-bays is always occupied and not permitting cleaning.

This was his statement:

> "Wayfinding, flexibility of the space, bedroom should be big enough and single patient room preferably, good view from the patient bed to the outside, clinically insured such as medical gas, lighting level is good, well organized, space to eat and sit. It is interesting because there are different clinical cultures in different countries. In the UK, you can see the patient from outside in bed, in Switzerland, it is not important and Jordan, as well in private hospitals and they should be like hotels. Always try to get light at the corridor so you feel close, in Scandinavia, they can have dining room for patients and relatives, comfort and dignity, their privacy when they require it. I think rooms should be single because of the recovery time, cleaning process as you can never clean the ward because its' always occupied, infection control as well. I'm against the ward and multi-bed bays because of the different states of the patients and cleaning and comfort" (Interviewee 3).

One designer noted that their architectural practice designs hospices, which are not different from hospitals apart from being domestic for palliative care purposes, yet they still need to be functional as well. His statement was support as follows:

> "As designers, we build hospices and we try to do them more functional and to be more like domestic side. We have been doing that for 30 years. We follow the regulations HBNs, HTMs, the valuable data for feedback in terms of POE, essentially for designers is the space, are the spaces working well together?, room adjacencies, reception location, if WC is in the right location, are the treatment rooms well located for the bedrooms?, so spatial relationship. Travel distances, if they are too far between nurse station and rooms, corridors itineraries. Does the space give a sense of well-being?
>
> The space helps a lot in improving the well-being. Can the patient control the heating ventilation and windows? How to quantify the space in well-being? Light and shading is important as well. Hospices do not need to feel clinical. Spatial flows and corridors," (Interviewee 5).

He also added that there is a need for a connection between spaces and control environment by saying "connection between spaces, wayfinding, we dedicate en-suite in the single bedroom. It's important for the privacy and dignity of the patient, control environment. Bed-head choice, comfort, put patients and visitors at ease, adjust the light" (Interviewee 5).

In addition to these criteria, designers use HBNs and HTMs as a benchmark for the design besides of collecting data from previous projects and lessons learnt. They also use the brief, guidance as well as their knowledge and experience.

> "Clearly the clinical spaces, the ergonomic that functions for the patient, the clinical staff and the environment, their view out, is it a pleasant aspect, good windows, good ventilation, good design for management. For example, a bedroom is particularly important because you do not want to get it wrong. So in terms of criteria, we look at the written guidance in the form of HBNs and HTMs we use that as a benchmark, and we obviously go to collect data from past projects and past experience designs. We look at reviewing the brief, whether they are looking at specific things or basic standard design. It's a combination of all of these 3 brief, guidance and their own knowledge and experience" (Interviewee 10).

Designers were also asked about the stage, they start using feedback from healthcare users and facility managers, whether it is during the concept design, the developed design or technical design.

Thirteen designers argued that the use of feedback is done at the early stages of the design, which is the concept design or during the preparation and brief. Unlike one designer, who said that it could be done during the stage 2 'developed design'. Interviewee 2 explained that they use the feedback, starting from the stage 2 because they need to know the function of the building before using users' engagement. Her quote was as follows:

> "Stage 2 developed design, because you need to know how the function of the building is going to be. We don't use engagement or user feedback at concept design, but we receive a brief of the requirements, which explains what is needed and what is not" (Interviewee 2).

Her answer was followed-up by another question about the data if they do not have enough of it. She said that a benchmark of the project is done, followed-up with colleagues' experience as well as developing models of care from healthcare trends. Her quote was as follows:

> "We would benchmark the building against other projects we did, then we use colleagues experience, we look at the trends of Healthcare and we try to develop

models of care. That's how you would start to give more shape and form to the building" (Interviewee 2).

One of the designers shared her experience of using an in-depth POE in 2000. She further added that they asked the NHSI 'National Health Service Improvement' to discuss the possibility of incorporating the POE into HBNs. She also explained that P22 'ProCure 22', which is a type of health construction procurement, issued a set of guidelines for design and build that, is concerned with POE. Her feedback was as follows:

> "This is one of the things we want to address, P22 'ProCure 22' have just issued a new set of guidelines for design and build, and one of the main criteria is the patient POE, at the end of the job it has to be done, and at the moment there are very few projects that worked on POE. I worked on one real POE in 2000 that has been carried out by Durham University on southeast hospital. And it was an in-depth POE, but that was the only one that has been done, we discussed with the NHSI 'improvement' how the POE can be brought into health building notes that are guidance that inform the health buildings. We rarely refer to RIBA when it's about hospital design because it is all done slightly differently, because we go rounds and rounds of user meetings in the early stages of the design to establish what the users want, which is part of the briefing. It is very rare to refer to the RIBA, but obviously, it stays in the background that goes to the POE. I have been mostly concerned with space planning and user's feedback and user meeting and very rarely patient feedback. Within the last 10 years, we started getting patient groups feedback" (Interviewee 1).

Five designers said that they start using feedback at the early stages of the design from stage 0, which is called strategic definition according to RIBA. Interviewee 5 said that they develop the brief with the client first, then they control the expectations before the concept design.

> "From stage 0, we develop a brief with the client, and we control expectations before concept design" (Interviewee 5).

Interviewee 13 said that users 'hospital staff' are involved at the start of the project from the high executive people to the department' directors. The brief is developed from the design team that leads to develop the concept design, by engaging all users in order to get it detailed in the schematic design

> "We do it in the early stages of the design, in the UK we start engaging the users we call them users (hospital staff) starts from the high executive people who run the hospital then people who are directors of department. We develop a brief of what they

need, and then we develop the concept and engage all users for that then we get more details in the schematic design. It depends on the hospital how it runs" (Interviewee 13).

She also added that some hospitals select their representatives to attend the workshop where exchange of feedback is given "some hospitals select the people to get in the workshops during design. Then we go to design development and in the construction you don't have users' engagement".

Another designer added that they do have a clinical team that is part of the design, who share their feedback and opinions about the design in the brief and the business case; however, the estate team rarely involves the patient representative group unless there is a need to use colours and interior design. Moreover, designers use a scheme that helps in getting feedback form patients through the clinical team, which is fed back into another project before starting its design. This statement was supported as follows:

"It is only at the start because we have a clinical team who is part of the design process and they share their feeling in the brief and the business case. In terms of patients, it's not very often the estate team will bring an in-patient or a user group involvement until quite later if they tend to be using colours or interior design that's where they bring it. But, also we use the scheme we have done to get feedback from patients through the clinical team then we will feed that into another project which feeds up each project a little bit more before design" (Interviewee 4).

Another designer said that they use the feedback at the early stages, when it is related to footfall and distances from point A to point B in the ward. He emphasised that it is important to use feedback in the early stage in order to reduce the footfall, and knowing the functionality of the spaces in the ward that has an impact on its operation, he said that they would use the feedback throughout the project.

"You can start using it early on especially if it's a footfall, the distance from point A to B, if you can reduce that footfall that's early on in the process. You know the ability to get food in, cleaners in, the ability to change the bed linen, that kind of function impact how the building operate. I would use it throughout the project" (Interviewee 11).

On the other hand, four designers argued that they use the feedback during the concept design, as it is a critical part to start the design with an idea. Their quotes are as follows:

"Primarily during concept design" (Interviewee 6).

"Concept design, early in the brief, maybe info come at the briefing but get detailed later" (Interviewee 7).

"We start at the beginning concept design; we see the feedback we get, which informs the design, with the lessons learnt" (Interviewee 8).

"Concept design/ scheme design is a crucial part to start the idea" (Interviewee 14).

Interviewee 8 was asked about the lessons learnt they receive, as he said from the clinical team it could be anything about the functionality of the space including the location of rooms and their adjacencies, as well as their shape. From the FM team, lessons learnt was mainly related to the manufacture for e.g. ceiling.

"It would be everything from clinical point of view; the location of everything, the adjacencies of the rooms, do they function well, is it the right shape, the right place?, and from FM feedback about manufactures, ceiling, and anything in the room. We can get feedback about the function of the space and the location" (Interviewee 8).

The reasons for which designers use the feedback at the concept design, is the success of the project. Interviewee 10 explained the process of engaging users to get feedback as he said the feedback received is from different parties including the clinical staff, patients and estates facilitators. At the beginning both the clinical staff and patients share their feedback, when the design progresses, designers liaise with the FM 'estates facilitators' as they inform them with the material choice and their lifecycle replacement. He also added that throughout the project, other people might be involved to share their feedback.

"Hmm, certainly we start at concept design because the earlier we get informed through the design process the most successful the design should be. Through the design process, we get feedback from different parties, clinical staff, patients and estates facilitators. We get feedback from both patients and clinical staff but when the design progresses we then begin to liaise more with the estate facilitators because they have an interest in the type of material we use, lifecycle replacement. As the design stages move through design process we look to engage different types of people to get the most information we can" (Interviewee 10).

Another reason for which designers use feedback at the concept design, is that the FM team gives their feedback regarding the geometric side in the technical design; however, regarding the layout it is at the concept design, since the technical design is only about the M&E 'Mechanical and Electrical' engineers. One of the designers said that the same people are involved at different times and stages:

> "It's mainly during the concept design, because the FM side inputs geometric technical design. However, for actual layout, it is at the concept design working up to stage 3, but you use more feedback from user groups. For example, we finished a project converted to a hospital and we attended a series of meetings to meet users, and they all want different things. Not only the clinical staff, but from different aspects, they all work together. When you go to the technical design this is more about M&E, so we get people at different times and different stages" (Interviewee 9).

In fact, one designers said that the earliest the better; however, it depends on the project and the part of the design left. They may get involved straight to the technical design to look at the medical gas supply if the project is refurbished or renovated.

> "I think we prefer at the earliest possible, but it varies a little bit when we get involved in the project and how much work has been done before us, sometimes you get directly to the technical stage. Sometimes it could be beyond the technical design regarding the medical gas so actually the feedback it could be all the way through the design" (Interviewee 12).

This designer was asked about the FM and the reason they do not get involved at the early stages. He responded that it is difficult to get everyone at early stages of design, especially from the estate team, yet it would be nice to have them.

> "It's the difficulty of getting anyone at the early stage of the design particularly from the estate level; it would be nice to have it early" (Interviewee 12).

Moreover, it could depend on the location you work from, as in the UK, they start using the feedback at the early stages. It could also depend on the detailed brief. Interviewee 3 added that feedback affects the design with 15% only, as he explained that they generate the feedback in their practice where sometimes they start designing without having feedback.

> "All of them, but it depends on where you work. In the UK, it starts at the early stage and it depends on the detailed brief, the skill of architect is hearing what is useful and what is not useful. However, in the UK, in concept design you would have 20 to 30 meetings up to 60 meetings and meet project owners once a week, that is where we use the feedback. Feedback affects 15% of the design since we generate it in the studios; we start designing without hearing feedback" (Interviewee 3).

Another question was asked to designers about the capture of feedback and its reuse. Interviewee1 said that they need to encourage the patient's users group to share their feedback, as they are important in the process, yet difficult to get unless the trust enables it.

> "We need to encourage the patient's users group because the design team struggle to get it and they do not have the opportunity to see the patients unless the trust enable it. It doesn't always happen, I had this opportunity once with a hospital who had an advisory patient group, and it is becoming more common now especially with the new guidelines and the building notes" (Interviewee1).

Although, some information are not captured because some designers are told so, the only tool they use to capture the feedback is mainly verbal or notes on drawings.

> "Some of the information are not captured because we are told so. The tool we use, drawing in the meetings, mainly verbal feedback, we could have workshops sometimes to see what comes at the end. We write notes on the drawings" (Interviewee 6).

Interviewee 3 added that the capture of feedback could be through listening to the contradictions, limitations and positive comments that are later implemented on other projects when they are useful.

> "You listen, and point out where the contract contradiction and where there positive comments which need to listen to, minutes, we implement them on other projects by reusing them and if they are useful or not we push back to find more feedback" (Interviewee 3).

However one of the designers said that they never had feedback from the FM team, yet they still use a POE format in their management system and they do not have the opportunity to see the engineers and clients as they work mainly for contractors.

> "We have a POE form in our management system but we quite often work for contractors and we are sometimes prevented of seeing engineers and clients, because our client are the contractors. A series of questions and a format with the end user of the building and never had feedback from FM" (Interviewee 7).

In addition to the drawings' mark-up and the POE format, meeting minutes is another option to get feedback from users as well as photos, notes and VR 'virtual reality' that helps in the meeting to visualize the space. This was stated in the quote below:

> "We start with 100 scale and a series of diagrams, explaining the views of the daylight and staff and everything, then we move to a scale of 1:50 and we explain on the

drawings what we have designed, then they mark-up on the drawings and we try to put those in meeting minutes as well. We try to understand what is really important to them then adjust accordingly. So meeting minutes, drawing mark-ups, photos, we take notes, and sometimes we use VR in the meeting to help the process of visualizing the space. Before we implement anything, we take a step back and we see whether it is really working or not. After that we have another meeting we bring back the previous notes and feedback and photos" (Interviewee 2).

Interviewee 12 added "drawings, we model it up, and it varies as you go through the process, mark up on the drawings, minutes, sticky notes on the wall, and photographs, we capture the information and we use it again, to the next project, it gives you like a baseline" .

Another designer argued that they use the traditional method by taking notes and minutes and by creating a design decision matrix, which is a schedule of recommendations. Moreover physical adjacencies with the brief helps the design team in making design decisions as well as room datasheets that are reused through practices, and other projects.

"We do more of a traditional way; it could be through minutes, design referral notes. We can also create a design decision matrix, which is a schedule of recommendation, physical adjacencies with the brief that helps us in making design decisions, room datasheets. We reuse them through practices and other projects" (Interviewee 5).

Furthermore, a tool called BlueBeam, which is an advanced version of pdf and used by designers where they can project on the screen and use it to capture feedback by drawing upon it and making comments that are translated into Revit models. This was supported as follows:

"I use Bluebeam, you can project on the screen in front of people, a grown up version of PDF. You can draw on it and make comments this pdf version on Bluebeam can be translated into Revit models to capture feedback live although it takes time. We reuse it by taking back to them in the meetings" (Interviewee 13).

Another designer noted that feedback is sort of knowledge and experience, which is in a centralized system within the practice where all designers' ideas and knowledge are stored. Feedback could be reused through dialogue and conversation between designers and clients about the designs that worked and the ones that did not work. This was supported as follows:

"I suppose most of it is sort of knowledge and experience we build up as a design team, having a sort of central place to keep all designers' idea, which we think it will

work well because we are such a small team. We can talk about any scheme anyway, so it is a sort of dialogue thing in terms of feeding back that information into the design process. How to reuse it, hmm, well if something works we use it again and we tell the client this is what we have done on a previous scheme, this is what was good and this is what worked and we use it on that scheme. Clients want to know what worked and what didn't work on other places" (Interviewee 4).

His answer was also followed-up by another question about the feedback and if the client asks for new type of requirements in the brief. He then explained that it depends on the clients, as they may have the estate team and sometimes the FM would be along with the clinical team where they get a fortnight meeting with the clients and they review together the feedback and try to incorporate new ones.

"It comes down to particular clients, some clients have only the estate team and sometimes it's the estate team along with the clinical team, so we tend to have meetings every 2 weeks and we review together and we get feedback and incorporate it into the design" (Interviewee 4).

One of the designers suggested that having workshops, where people can freely share their feedback and opinions about spaces functionality would be great that should be scanned and stored later on in their database and reused through meetings and exchange

"Often it's written, in the meeting we take notes, and we make a template of specific questions that we need to know about, then we write our report based on the meeting we had. We would encourage having workshops where people would have more freedom to write, we encourage people to write notes on the space how it functioned, etc. Then we store it on our system, we scan it and then we put it in our database, we reuse it through a HC form and in the meeting we share the knowledge we gained in the group email. The feedback will be captured in the meetings and through engagement of users; we can get the feedback, share it and use it" (Interviewee 8).

One designer said that they use it in the traditional format, however they do not reuse it because they do not store it, yet it would be great to use for future projects.

"We take minutes and take feedback from different parties and we try to negotiate sometimes. For the time being we do what the client asks from us, we don't reuse it but I think it could be if we could store it to use for future projects" (Interviewee 14).

In addition to the traditional way of doing, Interviewee 10 said that now they use a spreadsheet with comments that is easily manipulated; however, retrieving it is hard as not everyone is aware of the placement of the projects and the type of data stored.

> "Number of ways obviously all written. A spreadsheet and we record comments and we flag them sometimes if they are important. Traditionally we used to use minutes, but now we use more spreadsheets with comments, which is more easily manipulated. It is stored on each project and each project has its own unique folder, and will be stored under a schedule, which sometimes it's difficult sometimes to retrieve for future project because not everybody knows which project they refer to" (Interviewee 10).

One designer emphasised the importance of POE that helps in getting feedback and facilitates the task of designers, who store electronic records of the meeting notes and scanned briefs.

> "It's literally mock ups, we sit in the meetings and we mock up, the paper will be scanned and we electronic get records. Therefore, we have a permanent record of what was agreed in the meeting, we keep records of meetings, scanned briefs. How we reuse it, well a lot of feedback is project specific; this is where it needs to be saved. However, you do not always pass on the knowledge, everyone has specific knowledge and not everyone has access to it. That's why POE is important because it helps in getting feedback" (Interviewee 9).

One last interviewee explained that POE is part of the process to capture feedback that is stored in a knowledge base. He also added that people' experience are valuable and need to be captured where they can do a learning exercise to drop feedback in the knowledge base of components parts.

> "Several methods like POE at the end of the project, which will be following generally across the design process to begin with, which will be key sign of stages. So, from HC generally it is strategic airline case, airline business case then full business case. So generally, it is the internal gateways for healthcare people side and outside the gateways of process, which will be planning, building, control and get a guarantee of the maximum price and definite procurement gateways as well where you can capture and check what has been done. How to reuse it we capture in a knowledge base generally, people' experiences because they are valuable. Because you can do a learning exercise and drop it into a knowledge base of components parts" (Interviewee 11).

Designers were then asked about the type of useful data or information they get in the design of hospital wards from FM and healthcare 'HC' users. Two designers said that they have no idea about it "I don't know" (Interviewee 5 and Interviewee 13). While one designer said only some requirements without giving more precisions "some requirements" (Interviewee 14). One of the designers explained those requirements that possibly may help in the design that are about the space whether it is adequate or not and from the FM team about materials and their lifespan.

> "Users would say whether the space is adequate, from FM, which materials work and which don't and material lifespan" (Interviewee 7).

Design guidelines such as HBNs and HTMs and health architectural site can inform the design; however, they are not specific and not provided at the early stages of the design. Designers can model from the ADB 'Activity Database' for the department of health, yet not everything can be designed through design guidelines due to the specificity of the building. Tis was supported as follows:

> "There are documented notes like HBNS, HTMS, health architectural site, and lot of this may be generic. But, at the design stage you might not have this information. You can model information from ADB for example but you can't model everything since it is very specific" (Interviewee 9).

Three designers talked about the use of HBNs, HTMs and ADB as a starting point of design and basic principles. The brief could be generic or specific depending on the clients and their requirements as it could be heavily contractual.

> "We start with HBNs and HTMs, it's a general brief but depends on the client, it would be heavily contractual" (Interviewee 6).

The requirements could be schedule of accommodation and the list of equipment they use on wards.

> "Schedule of accommodation, any special equipment they might want to use, although most of them are standardized. We design with HBNs and HTMs" (Interviewee 2).

In addition to the choice of materials and products, and from the HC team it could be the services such as X-rays and scans; however, in case these information are not received then a back up to knowledge and experience is necessary.

> "HBNs, HTMs, we start it with a base point and ADB, that are basic principles which we use to discuss with users in the brief. The kind of info, from HC users it's the service, X-rays, for example, the FM what are the design criteria choice of materials and products, if not we reflect on HTMs and we use our own knowledge and experience" (Interviewee 8).

Five designers emphasised the importance of getting feedback from the FM team, who can provide them with a brief that covers the ergonomic requirements related to the space requirements such as the area schedule, adjacency matrix, and materials choice. Moreover, they could offer a policy statement for each department, such as fire and management policies.

> "From the FM often there is a brief which covers the ergonomic requirements and that will be the space requirements so the area schedule, with an adjacency matrix, which tells us the critical adjacencies for particular department and spaces, and the materials brief. So generally, the estate will tell us what kind of material they prefer for outside and inside the building because they have their own knowledge of lifecycle about good and bad materials. They offer us policy statement for each department and across the estate policies for fire, management. It can be varied what they provide us" (Interviewee 10).

Furthermore, HC team and FM users' opinion is important as feedback received could be from a personal point of view in terms of experience or could be pragmatic as some estate facilities do not like a type of floor as it was not efficient for them and want it to be changed. As wards are not general all the time and most of them are specific, the feedback received will be specific.

> "Some products are better than others, and that's generally the experience of people in the hospitals, personal opinions or it could be equipment, for example changing the type of floor because it was not efficient, sometimes it is pragmatic response. From HC users, if it is a general hospital ward you can apply a standardized model. You have different types of wards that are technical and specialists. The general ward is very basic in what is supposed to do and it is not really medically specific" (Interviewee 11).

His answer was followed-up with a new question about the brief when it is not well received and the way they tackle this problem. He said that they again refer back to their knowledge and experience.

"Well we default to our experience and knowledge" (Interviewee 11).

One designer explained that before designing the ward, there is a necessity of awareness of the issues in that ward such as nursing and their workflow, emphasising that feedback got from FM is extremely important. He also said that the design is an important factor that helps in the process of patients' healing.

> "If we design the ward, we would know what kind of issues there are in terms of nursing. Design affects the patients healing in terms of safety, is the building we feel at ease? FM are terribly important to get feedback from" (Interviewee 3).

Nevertheless, the design without the FM side would be incomplete as they are the ones who provide information about the project, such as the standard equipment list, which they review and discuss in case it is changed or kept; they are important. Yet, designers do not get huge feedback and all necessary information from them. This was supported as follows:

> "The FM side knows already what is going to be, so they provide that to us, they have like a standard equipment list and that standard equipment list they review if we have any feedback from other scheme such a particular item if it's working or not working and change it or keep it. We ask the clinical team if it is working, as they want it to work and feed it into what we do in the future. We do not tend to get a huge amount of feedback, and we don't get to know what's going on outside, you can get completely different requirements between hospitals" (Interviewee 4).

Another designer explained that the variance in the hospital projects could be the numbers in the business case that keep changing, which should be published and available. Although, there are information they do not get such as, environmental behavioural and feedback from HC users, they still refer to their best practices from their previous projects. Knowledge and conversation from users' engagement could be helping in the design process.

> "If you are starting a new project and you do a business case critically it's the numbers that change initially, it could be stays on the ward that information is published and should be available to all. The bit of information that we do not get is the environmental behavioural, feedback from staff. What worked and what did not work and personal views. I think we are not really good at capturing feedback, it becomes like a silo peace of information, for example if we do a ward, we get the best practice from our projects, the FM may not capture our new ways of working, I think we could do better collectively with the trust. Throughout the process we always try to capture information, I like healthcare because we try to help solving problems and

complexity of the projects and that knowledge comes from engagement process and conversation with the clinical staff of how they use the space" (Interviewee 12).

However, one of the designers mentioned that FM is neglected in the process, as they do not get involved in the beginning of the process, which makes it difficult for the design team.

> "FM quite often is neglected because we only see facility managers too far down the line so instead of saying at the beginning how you're going to deliver the services whether its food or waste management or heating or lighting or landscaping, how you are going to manage these, what do you need? What sort of information do you need from the design team? Too often it is considered if it is in-house which is rare these days but if it is related to waste management, it's hard to get the information in" (Interviewee 1).

She also added that some issues cannot be dealt only from the FM side such as the collection and treatment of medical waste, but mainly as a management issue.

> "Some of the FM collect the medical waste and put it in the warehouse without being treated because the FM can't deal with this only. I see it as a management issue" (Interviewee 1).

Her answer was followed by a new question whether it is the design team or FM' responsibility. She responded that designers, FM and clients should be involved at early stages of the design, yet because they do not get involved, the briefing time gets short and mistakes could appear down the line.

> "Well, it's the project managers who should be programming in all these information, so at the start of the design we need information from the patients from the design team, from the medical staff and we should be able to tie it in the design process, sadly that design process is never long enough. The whole briefing should include all of these people before the design, but they are not included and the briefing time is short. Quite often, the client comes and asks what my hospital is going to look like and they want to see drawings and presentations. I had the same problem in one of the hospitals I worked on in Tlemcen (Algeria). We did a wonderful façade but we didn't know what was going in the hospital, before we finished the brief we realized there was a mistake. The whole briefing process was too short and we realised that there were many gaps" (Interviewee 1).

Additionally, she added that it is a management issue from the clinical side as well, since project managers had to cancel the meetings they organised with them, which could harm patients and their environment. Her statement was as follows:

> "Well it's relatively easy to organize meeting with the user groups. I have worked on projects were important clinics were cancelled so it is a management issue that could harm patients. It's difficult but needs to be done properly" (Interviewee 1).

C/ WHAT DOES NOT WORK?

Designers have also been asked about the missing data or additional data that could be useful but not exploited on time, as well as the reasons for which this data is unexploited. As explained to them that unexploited is the knowledge lost during the construction project process, as it is not taken in consideration at the right time unlike the exploited knowledge that is taken ahead of the process within the brief or feedback given by the client and users. Two designers mentioned that they have no idea about it.

> "I don't know" (Interviewee 5 and Interviewee 6).

While two other designers said that they don't get patient and users' feedback, yet their opinion would be a great in getting, besides of the solutions they prefer to have for future buildings.

> "We don't get patient feedback, and their perspective will be nice" (Interviewee 2).
>
> "Satisfaction of patients and people working in that area, what are the solutions that they want to have for future buildings" (Interviewee 14).

Furthermore, Interviewee 12 said that the data not received could be about the way of cleaning the clinical spaces from the FM side, as well as the ground conditions.

> "We get told how often the room is used by the estate. The healthcare trust knows how the building works and the number of patients they get at the door. The true utilisation of FM spaces is quite difficult and potentially is challenging to clean the clinical rooms. We always want to know about the ground conditions" (Interviewee 12).

One of the designers noted that the project could be well achieved in case of having a good brief and a good client who has a very clear idea about what needs to be done in the project.

> "You get good buildings when you have good clients, and a good brief, but when you get a client that has a very clear idea of the building you achieve a good result. The most important thing is what the client wants" (Interviewee 3).

One designer explained that they get a short and not detailed brief from users and the trust that needs to be developed. The problem is that not all information are in the brief about the project, which is either a refurbishment or a renovation, and the trust does not think thoroughly about it, besides of the budget.

The design team needs to know placement of the waste facility, public transports access and other questions related to patients, yet the information are not enough even when the design team starts working on the project there are missing information that have not been provided by users. The designer thinks that the data is unexploited because of financial, political and timing reasons.

> "We often get the sort of brief from the trust and users, what we want is to develop it. Generally, we get a short brief from the users and not detailed. We have to ask a lot of questions but the brief doesn't include them. These days it's not about a new hospital but a refurbishment, a renovation and it's very rarely thought by the trust. We get a short brief and the users say we need to spend 50 million on the project and we want all of these, the design team looks at it and starts asking questions about waste facility within the area, public transports and patients' related questions. We don't get the whole picture, we get a third of the picture and it's so difficult. In addition, sometimes the design team start with the information they have and it's not working because it's not enough. It is not exploited because of the lack of money, and they think that's going to be quickly to get the project, so I would say the finance, politics and time and we never get enough of all of these" (Interviewee 1).

Although designers attend workshops with healthcare staff and users, where they can provide their feedback and opinions about the project, one of the designers said that capturing the feedback from users during the meetings is challenging as it is individual project, intangible and should be written to be stored. The only method they use is marking-up the drawings and scanning them to archive them later for reuse.

> "We have workshops with healthcare staff and users, and they tell us what they want and what they don't want and that's something difficult to capture because it should be written. They react on the drawing and you can't easily capture their feedback. It is

not exploited because it very much individual project, and like I said we reaction to drawings and I don't know how to capture that. We mark-up drawing and scan them then keep them. It is kind of intangible to capture it" (Interviewee 7).

Interviewee 13 explained that designers refer to guidelines in the design and show plans to users; however, the client and HC users do not know how to read plans, which is why a 3D model is shown and explained to them. Furthermore, designers build a mock-up room replica of a typical patient room and show it to users and healthcare staff who give comments and feedback and make changes about it.

For example, they might suggest a new placement for the oxygen and the bed orientation.

> "We follow guidelines, and refer to it. The users can give their day-to-day activity, they don't know how to read plans so we show them 3D and we explain it. we build a mock up room which is a replica of a typical patient room, so all users who will be working in a hospital and other users go and see it and suggest making changes, for example the oxygen on the side or in the middle, bed orientation, the ceiling montage etc." (Interviewee 13).

One designer added that the more you have people on board the more you have chances to get everything right, by explaining to users the limitation of the budget and spaces; however, the opportunity of speaking to everyone is not available. The additional data needed could be staff feedback and patient outcomes as the design is built for them and having their feedback could help in improving the design, hence their state. Yet it is hard to get it, besides of Trust feedback since they know what they want to get, still they do not inform designers of everything.

> "Basically, when we don't get the opportunity to speak to everybody in the briefing stage, the more people you can speak to the more chances you have to get everything right. It's also, when the consultants are basically told this is what you are going to have, and everybody understands there is a limit on the budget and space. As long as you had that conversation with them in the start, you both understand what compromises but it is a problem when you can't get a chance to talk to everybody. Kind of additional data is probably the patient outcomes because everything we deal with is all about patient outcomes. If there is a simple way of doing it to improve the patient state, that's a massive benefit to the NHS, but it is complicated to get. From the staff as well, if they are happy, and makes it easier for the trust because they don't have recruitment issues. They are often told when there is a refurbishment that the

staff is much happier. So everything goes around patient and staff if you get both of them then you get everything right. Regarding design data, if we don't ask the information we don't get it, the trust get a better understating of what they want with the standard equipment list, some trust don't have this process of going through the project to get the value of it" (Interviewee 4).

One designer added that although they touch on existing buildings and survey them in terms of room accessibility and incident and recovery rate, they do not get feedback from FM as these information are needed at the early stages of the design.

However, facility managers do not get involved in the early stages of the design because they like to see tangible results physically rather than technically.

> "We possibly touch on existing buildings, simple surveys on the access of the rooms etc. We can capture the incident and recovery rate. From the FM, it is quite good; sometimes they are pro-active to get the design at early stages, although it is difficult sometimes to get their engagement in the early stages of the design at the concept stage because they want to see tangible results rather than technical design. Trying to get the FM at early stages of the design is difficult because they are not used to this kind of discussion, they prefer physical rather than technical" (Interviewee 8).

Another designer emphasised the issue of timing as they may ask for information regarding the design and the materials used, which come late on site, yet the client still asks for it to be implemented. He also added that they receive the schedule of accommodation and adjacency matrix, as well as the client aspirational brief. The missing information that lead to failure in the design are about material selection and technical design related such as wall and ceiling finishes. Moreover, clients do not attend the meetings highlighted by designers due to their schedule, which leads to unexploited data due to time constraints.

> "The problem is the timing of the issue of the material that is often used causes more difficulty, we ask for a particular piece of information, and it is materialized and we pass upon the design and the material comes but it's late after that and the client says sorry it's late but it needs to be implemented. So usually, we receive a schedule of accommodation and adjacency matrix, they are the two main components. We receive an aspirational brief for what they would like to achieve. I think what we don't receive is about material selection, related to technical design, more about wall or ceiling finishes, that's a common failing if we don't get it. They are not exploited, because of their time constraint, we try to highlight meetings to abstract what they need but they ignore because of their day job and business" (Interviewee 10).

One of the designers clarified that, existing built could be a challenge as they need to know the adjacent departments, hazards and risks associated to it and if it needs to be changed. The reason, for which data could be unexploited, is the way it is stored as it could be lost within a month time. His statement was as follows:

> "The information we don't get, well sometimes when it's an existing ward it will be the existing data so the quality of the existing information that build where the drainers are that's the kind of pragmatic thing. That can be a big issue the starting point what we wouldn't have, we generally know in terms of standard if it's a general ward, single bed bay, multi bed bay whatever. We understand that, it's fitting in within the context of the existing is generally the challenge and the application for the pragmatics of actually building it. What the hazards and risks associated with the amount of work and that facility. What's the adjacent department, is there going to be noise disruption, do we have to put new drainage put throughout the floor which in case the ceiling can changed. It could be quite a lot. Why unexploited; it's available in the data state records, sometimes the record is not that good, but you would be surprised to know how quickly data can be lost and it can be lost in a matter of a month" (Interviewee 11).

His answer was followed up with a question about the reason data get lost as he mentioned that the information are not centralized and could be vague.

> "It is department function, it's the value of the information that has been provided, It should be placed centrally on the server or something, but clearly it doesn't. Sometimes it could be fundamental, if we get it wrong it affects the running of the hospital, and sometimes the information we are connecting to could be vague" (Interviewee 11).

Interviewee 9 said that the management of feedback received is another issue, as all stakeholders would like to share their opinions, which they need to be well managed otherwise; designers would get overwhelmed with the information that will be lost.

> "If you have a meeting and you are trying to get information out from the people and they all have their own opinions. They are all trying to share information but it is not well managed. If for example is the first time you know the user groups they are going to overwhelm you with the information and what they want, but it's a knowledge experience to get the knowledge out of them. They don't obviously always

know what they want and they try to tell us. It's easy to show them with a 3D model so they can understand" (Interviewee 9).

Interviewees were also asked how to use this data better if they could have it. Two interviewees said that they do not know how to do it.

"I don't know" (Interviewee 6 and Interviewee 13).

One said if they do not know the data, they would not be able to know how to use it.

"If we don't know it we would not be able to know how to use it" (Interviewee 3).

Designers argued that the data should be available on time, so they can have a clear view of the site by incorporating it at the early stages of the design, documenting it, standardising explicitly and sharing it.

"Firstly, receiving it is the most important thing in the appropriate time, if we are in position of the information we normally review it and if we think it might not be the best answer we change it and provide something it could be better. If we had the information we would use it to the best of our ability" (Interviewee 10).

"It should be incorporated in the process at the earlier stage, it is quality information you know! If the data is immediately available, it changes your attitude to the site" (Interviewee 11).

"Documenting, standardizing in document explicitly, and passing the information on" (Interviewee 2).

Interviewee 1 said that the data could be about transports, patients' body, staffing ad finances, but without these information, the business case is insufficient.

"If we had full data, we can assess it. If we had knowledge about transports, patient's body, staffing and all finances, we could maybe assess them. The trusts tries to build a full business case but without sufficient knowledge, we do not think we can do it. And we need a more realistic approach" (Interviewee 1). .

Moreover, designers need to understand the whole process and the way it works, as the more data they get, the better solutions they achieve as well as feedback.

"It's the understanding of the robust process to get the details and understand how it works" (Interviewee 4).

"The more data we have the more we can feed into projects, and we can use comparisons as well we get feedback from rooms we have done before" (Interviewee 5).

"I think the more information we have the better to get solutions" (Interviewee 12).

One of the designers suggested that they could model scenarios, to get an understanding of the data that inform them about the environment and the impact it has on patients. In addition to HVAC system.

> "I think the way we design, we can model scenarios to an extent so we get data about how environment can affect each patient, the data get to inform us. Data about how ventilation and heating works for example" (Interviewee 8).

Three designers emphasised the need to share knowledge and incorporate in a knowledge bank.

> "If there was a knowledge bank you will be able to refer to it" (Interviewee 7).

Although, it is not easy to share knowledge, as it may vary from generic to specific, indeed POE, lessons learnt and the decentralization of information is necessary.

> "I think to use it better is to share it, sharing is hard because sometimes it could be generic information and sometimes very specific to certain hospitals, POE, lessons learnt through the job, and should be stored. However, it is accessible only if you know it's there. Central storage information where the information is but if you don't know what you're looking for you can't access and it could be used better by sharing through words of mouth maybe" (Interviewee 9).

Interviewee 14 added:

> "Data would be decentralized and distributed; the solution would be to decentralize the system".

Designers have been asked about the data that would inform better design, whether it is exploited or unexploited, which has been explained to them previously. Five interviewees said that they do not know which data would inform better design and decision making.

> "I don't know" (Interviewee 5, Interviewee 6 and Interviewee 13).

Interviewee 9 said that without knowing what is missing, you cannot know if it is better for the project or not, as they do not share, hence experience helps in filling the gap.

> "If you don't know you can't know what's better for your design. Experience help in filling the gap, we don't get everything because they don't share" (Interviewee 9).

This statement was confirmed in Interviewee 2 quote, who said that although knowledge could be captured in BIM format with a constant update, knowledge sharing is not easy due to cultural differences.

> "Knowledge could be captured in BIM format, then update it to not use it again. Sharing knowledge is a problem due to cultural differences maybe" (Interviewee 2).

Interviewee 3 argued that information always comes from the architect' side and that the client does not give anything.

He also added that the information needed could be about the project governance and procurement, as you cannot start designing a project before looking at the procurement, mentioning that his projects were part of Procure 21 and ProCure21+

> "I don't know, we provide more information than the client gives, the real information we need is about the project governance, everybody's worried about the schedule of accommodation. Before looking at the design of hospitals, you need to look at the procurement and how this building has been procured. We have done P21 and P21+ but we didn't do P22" (Interviewee 3).

On the other hand, three designers said that both are important:

> "Actually, sometimes it's good to have exploited and sometimes it's good to have raw data" (Interviewee 14).

Interviewee 8 said that exploited is a must to have in order to help them in their project, while the unexploited could be gained through experience and knowledge, adding that he worked for the healthcare sector more than 28 years and they still need the experience in order to incorporate it in the projects.

> "I think it's a mix of both, because you need to have the data that we know we are receiving that helps us work, while the unexploited would be through experience and knowledge, I worked for healthcare for 28 years, and we need the experience to incorporate this into projects" (Interviewee 8).

His answer was followed up with a question about the knowledge and the way they pass it onto their colleagues, as he said that by involving staff in the project at all stages and insuring that they regularly review and criticise it as they should improve their culture of asking questions as well.

> "Through involving staff in the project through every stage, through insuring that we have regular reviews, regular critiques, a culture of asking questions" (Interviewee 8).

Interviewee 4 supported this by saying that in case there is a gap, experience and knowledge can compensate it.

> "Well, you can fill the gaps with the experience you have when you don't get everything, and you compensate with your knowledge" (Interviewee 4).

According to one of the designers, unexploited data may lead to innovation and both exploited and unexploited are equal and they do impact the design scheme; however, possessing the unexploited would be a bigger impact.

He also gave a percentage of 50% each if they knew about the unexploited; otherwise 60% per exploited knowledge and 40% per unexploited knowledge if they did not know about the unexploited.

> "I think all data would lead to better design, maybe exploited data and data we already know is better. The data we don't know and unexploited and the data we ignore could be innovative and lead to innovation. I think they are equally important but impacting the design scheme, the stuff we don't know about would have the most impact if we knew it, 50% 50% if we knew it but 60% 40% if we didn't know it" (Interviewee 12).

Despite all data are valid, one designer argued that exploited data would help better in the project.

> "If you are exploiting it you must give it a value, it's all valid because it's feedback. I think the exploited will help" (Interviewee 7).

The choice of data depends on its availability, as it would be well received; however, a delay in getting it would lead to changes in the project hence shortfalls, which is why exploited data informs better design-decision making.

> "If it was available, it would be well received but if it comes late this will be a late change and that leads to shortfalls. It makes more informed decisions when you have the data" (Interviewee 11).

One designer said that although the exploited would be good, and the gaps could be filled by going back to the clients to ask them for more feedback, the unexploited are more important as they cost more.

> "Presumably, it would be the exploited but if we think there are gaps in the information, then we go back to the clients and suggest there are gaps and we are missing answers to that question. I suppose the unexploited information are the ones that cost more so I guess that the unexploited is probably the most important" (Interviewee 10).

Another designer said that the more they get information, the more it is better for the project, indeed getting information on time and sharing it would be better used, as well as spending more time in building the brief would help in exploiting the data better. However,

engagement from the project managers 'part, would be great in sharing information about the project, such as ground conditions as they do not get all information regarding it.

> "We need as much information as we could possibly have, and if we have it in a timely manner we could use it better and if we shared the data we could use it better and if we spend more time discussing the data and examining it and turning it over. If we spend more time building the brief, we could exploit the data in a much better way. Obviously there are some things that you can't always get, like I worked on a hospital but we never knew what was under the ground although we could work on the foundations properly. You need to know the ground conditions and the flat conditions first before starting the project and these information cannot be given easily. I think the project management as well should do their part before designing" (Interviewee 1).

Designers were then asked about the challenges and barriers to get or reuse the feedback received. The challenges could be management, financial and time constraints.

> "It is to do with management again, for instance if we weren't able to do the ground service on time, we wouldn't get the feedback, so I would say time and money constraint. We should get the proper time to know the users meeting and it should be at the initial brief, the trust not knowing what they need from us and them not having a thought of the staffing and how to deliver services" (Interviewee 1).
>
> "Its timely information, I think!" (Interviewee 3).
>
> "Time and programme are genuinely the barriers, budget" (Interviewee 12).

In addition to contractual issues that leads to loss of information as it takes a long process to get the information from the main person.

> "Budget mainly, contractor processes, if I want information about something that I think is not working. I have to ask the contractor client who then sends it to the project-co who send it to NHS who send it back to project-co who goes to client then comes to me. So even if I get it in one day it takes time to send it again, if I get it directly from them it would be good so it is contractual issue that can lead to a loss of information" (Interviewee 6).

Furthermore, the accessibility to the information in the right place and time as well as the right people could be challenging.

> "For us not having them in the right place and searchable" (Interviewee 7).

"One challenge is to get access to the right people to access information; we don't get the right feedback from FM sometimes maybe because it's difficult to get access to them" (Interviewee 2).

Another barrier to get the feedback is due to the confidentiality of information.

"A lot of the information that they share could be confidential to that hospital and you don't necessarily use that" (Interviewee 13).

Three interviewees said that getting feedback from users could be a potential to be aware of the requirements.

"Some clients come and say what works and what doesn't work" (Interviewee 5).

"I believe that getting surveys from users what they think. If the client addresses survey to the users, we will be aware of the requirements" (Interviewee 14).

However, accessing patients' outcomes and feedback is not easy as it is confidential and sensitive, yet the process would be faster if they could get it.

"It's very hard to get the patients outcomes, I don't know whether because they are not looking at much details and how is compared to other wards. It will be faster if we got it, it might be sensitive information for them that why we can't get easily but it would be useful if we could get it" (Interviewee 4).

Accessibility to providers of information and its quality as well as the programme is another barrier.

"It's about the quality of information and how accessible the providers" (Interviewee 10).

Although, another interviewee explained that time dealing with the client is another problem.

"Time scale is the difficult one particularly with the client, as it's an environment they have pressure to do their day job" (Interviewee 8).

He added that there is a mandatory procedure to use POE with clients of 1 up to 2 years, information could be stored on P22 repeatable rooms and feedback is gained.

"Part of P22 there is a mandatory POE you have to do on 24 months and 12 months, so there are standards to say that feedback have been gained. We could look at P22 the feedback posted; there are processes they are trying to share the knowledge on like P22 repeatable rooms" (Interviewee 8).

Nevertheless, two designers said that these are not barriers to get feedback as one said they do not know what they have not received to categorise it as a barrier.

"No we don't see any barriers, because we don't know what we didn't receive, so it's not necessary a barrier because you are not aware of it" (Interviewee 11).

The other said it is mainly called experience of how to work, as they need to involve users in order to get feedback.

"Not really barrier but experience of how you work, and involvement of users to get feedback, because if you keep them away you won't be able to get the feedback. Involvement is the key" (Interviewee 9).

D/ WHAT IS THE PROCESS OF USING FEEDBACK?

Designers have also been asked about the way they use, store, retrieve and reuse the data transferred to them by facility managers and users. Apart from one designer, who said that he does not know "I don't know" (Interviewee 14).

Thirteen designers answered this question in a different way. Two designers working for the same company said that the data is not stored anywhere, as one explained that if information is in the brief then it is already stored there, and if there are comments on drawings these will be stored in minutes; however it could be great if they could store them.

"Data is not stored or captured anywhere" (Interviewee 6).

"If it's in the brief that's stored, if it is comments on drawings sometimes it's on minutes but better if they were stored" (Interviewee 7).

One designer said that it is difficult for them to get feedback from users in a POE format.

"We try to get user feedback from POE but it is hard" (Interviewee 5).

Information can be transferred to designers in several forms such as written forms, paper documents.

"Information we get will be in several forms normally included in the brief" (Interviewee 3).

"We use it generally when it comes in a written form and paper documents" (Interviewee 10).

Design information can be stored in a project folder in the system the company uses; however, everyone in the company should be aware of the type of information stored and its placement.

"So we will file that stored in our system and project folder but everyone needs to be aware of it and where it is" (Interviewee 10).

The information is reused through discussion.

> "We will reuse the design in discussion with them" (Interviewee 3).

Furthermore, information could be stored electronically in a healthcare library as explained by Interviewee 2, Interviewee 4 and Interviewee 13.

Interviewee 2 explained that they create a set of drawings that are shared with the users during the meetings by capturing the key points. Furthermore, they constantly learn from their previous projects, in other words they use the lessons learnt stored in their healthcare library accessible to all offices in that firm, which they retrieve through diagrams and sketches in a visual format.

> "I think from every project we try to create a set of drawings and capture the key points of users. We constantly learn from what we did in the past to improve what we do in the future. We retrieve them through diagrams mainly or sketches mostly visual materials; we store them in our HC library in our server that accessible to all offices in the firm" (Interviewee 2).

Interviewee 4 pointed out that getting information from facility managers is hard; however, they can get it from the trust since facility managers, deal only with the health estate team, and added that information is retrieved from their digital library.

"From the FM side there is really little that they tell us about, we have a particular library for each client, and if we need any information we go to that library to retrieve it, it's a digital format. Form HC users if we get anything it will be through the health estate team, because a lot of FM deal with the trust, so if we need anything to know about it from FM side the trust can let us know" (Interviewee 4).

Interviewee 13 confirmed that feedback inform their design better where they store it in a healthcare database in their company.

> "Feedback inform the design for us. We have a database under the healthcare umbrella in our office" (Interviewee 13).

Data is captured through meetings in addition to the business cases, project records and feedback outcomes from the client either facility managers or clinical team.

> "It's captured through those meetings, some of the data are captured in the business cases, it's captured in our project records" (Interviewee 12).

He also added that the information is stored traditionally in files by the design team and the concept lead.

> "Stored by the people design and the concept lead, stored traditionally in files, and retrieved where necessary, we look at the lessons learnt" (Interviewee 12).

Another designer explained that they try to keep the data received from the clients for a minimum of 12 years, as each project has its own electronic file. Feedback is stored on a specific file.

> "Each project has its own file electronically, and we have specific file for feedback that we receive from clients that would be FM or clinical team, we keep feedback for 12 years minimum, and each file is dedicated for information and feedback" (Interviewee 8).

Designers also stated that post occupancy evaluation 'POE' is another mean of getting feedback, as well as having a constant contact with clients on a long term-relationship. The feedback is electronically stored in record machines, which is lessons learnt; these ones are represented by personal track of the project noted on notebooks or electronically filed.

> "POE or dealing with same people for projects in a long term, personal contact with people, store it in record machines (the lessons learnt) that are electronically stored. Regarding the feedback it's just personal track, maybe on your own notebooks, or electronically stored on the file, or record the outcomes" (Interviewee 9).

Interviewee 11 added that the feedback got from facility managers could be related to the type of machine they use for the flooring or cleaning or product alignment.

> "It would be through the electronic transfer, we would use the existing drawings. In terms of FM we ask about the product alignment, and what type of machine you are using for the floor and the cleaning" (Interviewee 11).

He also added that this data can be stored in the company's system which is the project specific, they can centralize the data for the trust for the client; however, clients are not always the same end-users, as one hospital may have a private finance initiative and a non-private finance initiative, hence the strategy needs to change.

> "We store it based on our sever system, which will be the project specific, we can centralize the data for the trust for the client, but the clients are not necessarily the same end users. So you may have a single hospital but it is split into PFI or non PFI or estate holding which in the case the strategy will change on the same side" (Interviewee 11).

Another designer said that building notes 'BN' have been written for more than 15 years and need to be updated and that design needs to keep up with technology as this one keeps evolving.

"Well, working on the building notes these are the area we discuss, what point the FM should join in and how can they help and how much information should you put in from the projects. I think personally, that the BN are repetitive and should be updated for each type of project" (Interviewee1).

She also added that from the facility managers, technical feedback is necessary that is related to HVAC 'Heating Ventilation, Air Conditioning', and from clinical team it could be regarding the scans and MRI 'Magnetic resonance imaging'.

She also mentioned that they retrieve data through research, reading and talking to people; this data will be then stored manually and used if necessary.

"So it's to do with the FM heating, lighting and that's the technical stuff. Regarding the clinical feedback, such as the clinical medical technology like MRI, Scans etc. change quickly and the design cannot keep up with it. If we design a hospital within 3 years, then we deliver it, the technology might have changed, so we need more bigger rooms, or a smaller room for equipment etc. Therefore, I would say keeping pace with the technology is a problem but there is no mechanism to get this, as it is too rigid the PFI system, we have to do derogations which is a nightmare. The BN has been written 15 years ago, why do have to keep working with something that's not updated. We retrieve it by research, reading, talking to people to bring the issues and problems. We store it manually and we don't use it necessarily" (Interviewee 1).

5.2 TECHNOLOGY APPLICATIONS IN TRANSFORMING TACIT KNOWLEDGE INTO EXPLICIT KNOWLEDGE

E/ WHAT IS EXPLICIT, TACIT, PATTERN LANGUAGE?

Interviewees were asked about their familiarity to the terms 'explicit knowledge', 'tacit knowledge' and 'pattern language'. In the earlier survey, only tacit knowledge was widely recognised as a basis for design-decision-making. The Thirteen out of 14 designers said that they have not heard those terms before and they are not familiar with them.

"No I don't know any of the terms" (Interviewee 4).

"No" (Interviewee 2, Interviewee 3, Interviewee 5, Interviewee 6, Interviewee 7, Interviewee 8, Interviewee 9, Interviewee 10, Interviewee 11, Interviewee 12, Interviewee 13 and Interviewee 14).

Apart from one designer, who said that she heard the terms but for her referring to building notes and design standards is important as she needs to constantly update herself in this digital age. Her statement was supported as follows:

> "I heard them but not being part of my vocabulary. All these stuff are in my head, I can get back to building notes, and ADB and have to read and update myself all the time due to technology change" (Interviewee 1).

Following up this question, interviewees were asked about their knowledge and the sources of getting them. All of them, emphasised that they get their tacit knowledge from experience, sharing the knowledge among colleagues, learning from past projects and referring to the design standards such as health building notes 'HBNs' and health technical memoranda 'HTMs'.

> "working for 40 years, experience, repetition, mostly by using the BN and constantly drawing and talking to people, expertise, it's always there" (Interviewee 1).
>
> "Experience, by doing" (Interviewee 6).
>
> "We do have a healthcare group in our office and information about projects tend to be shared and experience" (Interviewee 7).
>
> "My experience and knowledge, sharing stories" (Interviewee 13).
>
> "Experience" (Interviewee 5).
>
> "25 years' experience, networking, reading" (Interviewee 3).

In addition to networking while going to conferences for learning, continual professional development 'CPD', reading constantly and visiting the buildings for the observation side.

> "Mainly from experience and talking to colleagues and sharing that knowledge verbally. Reading as well, and visiting buildings" (Interviewee 2).
>
> "So experience, CPD, conferences, being involved in the healthcare sector" (Interviewee 4).

Four designers noted that it is important to work in the healthcare sector field to acquire knowledge, besides of the exchange between people.

> "From people who have a lot of experience in that field, I have colleagues who worked in the healthcare sector for more than 10 years so we get information from them" (Interviewee 14).
>
> "30 years of experience, it is implicit in my experience" (Interviewee 11).

> "That is what you've learnt from people, referring to design of projects you have done before, we also refer to HBNs, and HTMs, and there may be designs that go beyond the documents, which you keep in your head" (Interviewee 9).

One of the designers shared his thoughts by stating that even working in a practice for more than 30 years, they still need to talk to users and clients by asking them the right questions for knowledge purposes. In addition, they cannot rely on design guidelines only (e.g. HBNs, HTMs) because they have not been updated for more than 10 years.

> "It comes from early engagement with the client, and if possible, when looking at early stages design if suitable to have access to current method working, if tis suitable we would like to go and observe how the space functions and ask questions to patients" (Interviewee 8).

He further explained the problems of using the design regulations and the process of tacit knowledge where it comes from.

> "Everyone has different experiences and we need to access that. Regarding design tacit knowledge, it comes from experience and knowledge, learning. Our practice has been working during 35 years, still you need to talk to users and clients, the benefits is to ask the right questions. The problem with HBNs and HTMs is not updated for 15 years, so that is why we need to refer to experience and dialogue" (Interviewee 8).

This means that learning never stops and the more they learn the more knowledge they acquire.

> "Experience, the more we learn the more we get" (Interviewee 12).

Finally, one of the designers made a conclusion by stating that their knowledge comes from lessons learnt and explicit knowledge, which is accessible in books, manuals and written documents. The designer mentioned that by reading the explicit knowledge, which is acquired and transformed into tacit knowledge then disseminated again to explicit knowledge, is a sort of cycle, where both tacit and explicit knowledge interact with one another.

> "From what we have learnt and perhaps from explicit knowledge because we read constantly because explicit knowledge is constantly being updated. So, we use explicit knowledge that generates tacit knowledge and I suppose we disseminate that explicit knowledge in a developed form to tacit knowledge and the two sort of interact and come with a solution" (Interviewee 10).

F/ COULD TACIT KNOWLEDGE BE EXPLICIT (E.G. KNOWLEDGE REPOSITORY)?

Architects were then asked about the type of tacit knowledge that could be captured and therefore stored. Interviewee1 said that the information and knowledge could be better passed on and shared among colleagues verbally.

> "One of my tasks when I was working on hospital, we were working with a lot of young architects, I was the team leader, and they were asking many of how to do this and that, and I was reusing my information and knowledge by teaching them, passing on the info and that knowledge. It's better passed on verbally" (Interviewee 1).

She was further asked about the type of tacit knowledge that needs to be captured, as she said that everything could be shared and she focused on space planning.

> "I think you can pass everything that you have, for me was space planning" (Interviewee 1).

Four designers said that it is possible to do; however, they do not know the type of tacit knowledge that should be captured, yet the sharing is important and should be done on time.

> "I think the more important thing is to share it. I don't know what kind of tacit knowledge" (Interviewee 14).
>
> "It could, but how I don't know" (Interviewee 5).
>
> "Yes, but you need to transfer that in the best time" (Interviewee 3).

One of them said that she does not know clearly, what could be captured.

> "I don't know a quarter what's in my brain…" (Interviewee 6).

While Interviewee 9 did not understand the question,

> "You can't store everything in your head" (Interviewee 9).

One of the designers explained that the context of knowledge needs to be captured contractually to be used explicitly by users, adding that the reason for capturing that knowledge and how is important, and the more there is engagement from people the more they get information.

> "I think yes, the context needs to be captured to be useful as explicit, but I think you need to capture it and it needs to be wider. It should be captured contractually yes, I see more value and you still need it as tacit. In terms of people who use it, we need to be careful, so the more people we get on board the more we are better; how something is used and done is important so the how is important. How and why they do it, is the

key" (Interviewee 12).

Although one of the designers said that they would like to appoint someone to manage the knowledge in their practice, which comes from POE initially that has to be stored in a knowledge repository and used in future projects.

> "It should be yes. Tacit knowledge; any form of Poe is important, we have that on-going debate in the office and we are looking to appoint somebody to actually manage and improve the way we do convert our tacit knowledge into our explicit knowledge at the moment. This is about research need because most of that comes from research need and POE could be very good at collecting. Kind of tacit knowledge; for instance if we are designing a single patient bedroom, but the client asks for something unique, something we haven't done before and we have standard models for the bedroom and we look to create something that accommodates the success that's slightly different and it goes into a series of design studies. We try to record it and whatever the outcome is, will be recorded on that specific project because that will become the design. However, I think it should be moved across that sort of explicit knowledge repository because it could be something really interesting to use in the future" (Interviewee 10).

Two designers who are working for different companies said that they already have a system that helps in storing the knowledge that could be the design standards as HBNs and HTMs and building control.

> "We tend to do that with our members of staff. Kind of tacit could be the understanding of the standards that is building standards HBNs and HTMs Europeans standards, building control and that kind of thing" (Interviewee 11).

However, the person who needs to upload the information into the system should have an architectural background, or at least be aware of the project and the details to insert.

> "Our system is supposed to do that, it should be easier for searching and helping, because you're supposed to put a tag and detail in, but it's up to whoever uploads it into the system and put the details in, and quite a lot of people aren't really good at it since it is extra work to do. However, if it was regular, then who is doing it? Is it somebody not in the architectural background sitting there and typing? Then he would not necessarily know what's the details to put in and therefore doesn't necessarily put the right information in" (Interviewee 7).

She also added that the tacit knowledge could be the types of departments and hospitals, the experience of previous projects; the type of materials used as these could be a reference to use for future projects that needs to be archived.

> "Kind of tacit knowledge, I guess it's the experience of different types of hospitals, different types of departments, different materials that were used and worked, that kind of thing. If we did a project in the past, we could look at as a reference. In terms of design knowledge, we do archive all our drawings" (Interviewee 7).

Other type of tacit knowledge that could be captured is; the bedroom layout, the meeting outcomes, and patient' outcomes, such as in the ADB that has healthcare knowledge but needs to be updated.

> "It could be captured, there is no reason it won't be, if you put certain criteria to see what to share and what's important. The tacit knowledge that should be captured is the model of the bedroom layout" (Interviewee 2).

> "Yes the tacit knowledge could be explicit. The ADB activity database has a lot of healthcare knowledge and every type of room that is in it. HTMs and HBNs as well that's information becomes explicit, if it's up to date and how often they do it, even with the P22 that have repeatable rooms although it's a closed group. If all if these come together that is where the information becomes explicit, but the most referred to is ADB that has healthcare and all sort of design process make sure you have the standard information to start with. The kind of tacit knowledge is patient outcomes" (Interviewee 4).

One of the interviewees said that the time to share knowledge is necessary.

> "If somebody had the time to write it down maybe. Outcomes of the story is important. It is more about how interactive and how quickly you share it, but I don't think people have time to do it due to their business" (Interviewee 13).

Another designer confirmed this by saying that it is first a funding problem of capturing and storing knowledge on a regular basis, and second time and management issue as it requires people to do it. They could also capture users' opinions about the space, which is hard to get, as it is personal perception; however, BIM is a great tool to do this, which needs more investment, research and commitment

> "It could. There is a question of finance for being stored, and captured it requires people to do that on a regular basis as it's time consuming, and unfortunately because the NHS funding is not really available to do that, which why HBNs AND HTMs are not updated for a long time, although they are trying to do the ADB. To some degree,

the tacit knowledge is used internally in the practice and to expand that globally to have access to it again we go back to the budget it is a bit challenging. The data that should be captured I think is how the nurse could feel and opinion in the space. The data that is difficult to collect but also to interrogate personal experiences. BIM as process would be a great tool going forward; currently the success of BIM is to see how information is put into it, which still comes back to individual. The capture need more investment and commitment and academic approach" (Interviewee 8).

The interviewees were asked about BIM and whether they are aware of it and use it or not. First of all, from the findings, all the interviewees 'Designers' were aware of BIM and the benefits it brings to the industry. However, five designers said that in spite of their awareness of BIM, they do not use it at all as shown in their quotes;

"Aware and don't use it" (Interviewee 1, Interviewee 12).

Yet, their practice and team uses BIM, and this helps them in noticing the benefits of using it.

"Aware and don't use it but my team does" (Interviewee 3).

"Aware and do not use it but the practice uses it and almost BIM level 2" (Interviewee 8).

"Aware and don't use it, my projects use it but personally I don't and I get the benefit from it" (Interviewee 10).

While nine designers said that, they are aware of BIM and use it or semi-use it due to other responsibilities in their practice according to their quotes;

"Aware and use it" (Interviewee 2, Interviewee 4, Interviewee 5, Interviewee 6, Interviewee 7, Interviewee 9, Interviewee 11, Interviewee 14)

"Aware and semi use it, because my role is on the management side now, and we have a team that does the actual drawings but I used to do that before" (Interviewee 13).

Following this question, the interviewees were asked whether they use BIM on their day-to-day task, where eight Interviewees said yes as shown in their quotes:

"Yes" (Interviewee 5, Interviewee 6, Interviewee 7 and Interviewee 14).

"Yes every day" (Interviewee 9).

Two designers said they use BIM selectively depending on the project.

"Yes selectively" (Interviewee 3).

"Some of the time yes, it depends on the project" (Interviewee 4).

One of the designers said that she uses BIM on her day-to-day task, although she is not a specialist of BIM, she also added that there is a need for a BIM specialist to get more benefits from using it.

> "Yes, it has so many capabilities although I use 1 % of it, what we do tends to be repetitive, which is why there must be a BIM leader or specialist that can adjust our work practice to benefit what BIM offers" (Interviewee 2).

Whereas 6 designers said that they do not use it. Two of the designers who previously said that they are aware of BIM and use it, said that they do not use BIM on their day-to-day task, because of their role in the practice.

> "No but my staff do" (Interviewee 11).
>
> "No… my role is on the management side now" (Interviewee 13).

The four remaining designers said they do not use BIM.

> "No" (Interviewee1, Interviewee 8, Interviewee 10, Interviewee 12).

Following this question, designers were asked about the aspects of design information that could be stored in BIM. Apart from one designer who did not express his opinions "I don't know" (Interviewee 3). Thirteen designers argued that the information could be from a technical point of view such as HVAC, structural engineering and schedules.

> "I think all the technical stuff, engineering, heating, lighting and ventilation, building structures how it interacts with building services, and structure room building properties" (Interviewee 1).
>
> "Schedules" (Interviewee 5).

Interviewee 1 was asked a question about the design properties following her answer, as she said that architects needs to be comprehensive of the whole project and BIM can help them in visualizing the project beforehand. She also said that she would have used BIM if she was not retired now yet it still needs training.

> "Well, you need to be aware as an architect of what is going on inside and outside the space, you should be aware of the structure side for example, what if there is a beam there or column. BIM helps in showing the 3D project beforehand. I do not think that BIM prevents in architecture creativity. If I didn't retire I would have used BIM, although it needs training" (Interviewee 1).

Interviewees pointed out that getting a standardised room within BIM model can facilitate their task and makes the process faster, because there are drawings that do not constantly change such as toilets, patient rooms, clean facilities, staircases and corridors.

> "Standard rooms that shouldn't change, repeatable things like patient rooms, toilets. We have started an equipment library. We used to have software that help us in orientation of rooms" (Interviewee 7).

As explained by Interviewee 10, clinical spaces can change but other spaces like corridors should be fixed in BIM

> "Certainly standards arrangement, typical arrangement that are not going to change. Clinical spaces tend to change but supporting spaces like clean facilities should be same because they don't change and should be kept simple. Corridors or anything that has a statutory obligation should be set in Revit as a model type 1 and 2 in BIM, staircases, should be fixed by parametric in BIM" (Interviewee 10).

These standardised rooms could be broken into components like clinical washbasin.

> "Probably standardized rooms. In addition, we would break that into components like the wash basin, clinical wash basin" (Interviewee 11).

In addition to square meter rooms, mounting equipment, fire rating and acoustic level, which could be taken from BIM and dropped on a plan. This could save time and helps in coordinating the project between construction stakeholders and facility managers.

> "Required square meters for rooms, mounting high equipment, we tried standardised these it makes our life easier, fire rating, acoustic level, standardized room types, which you can grab and drop on a plan. It saves the time, it makes sense from an FM point of view, and construction point of view, predicting cost as well" (Interviewee 2).

Interviewee 6 said that they are trying to use the standard rooms without going through ADB, as it needs to be updated.

> "We are trying to get a standard room without using ADB 'activity database' because it's not updated" (Interviewee 6).

Although Interviewee 13 mentioned that, they can build the information they get in the design guidelines since it is repeatable.

> "We can build the information into the Revit model when it's about repeating the guidance or HBNs and HTMs" (Interviewee 13).

Another designer confirmed the effectiveness of BIM use. He explained that designers could input their previous projects and create a data set.

> "It's good if we put input of each project on BIM we will have like a data set" (Interviewee 14).

Furthermore, it is important to know how and why the data sheet could be used.

"It's all about the data sheet and the why and how it should be done, if we build up the data in the BIM model it would be great" (Interviewee 12).

Interviewee 8 said that in addition to clinical data, accident and recovery rate, it could be a great input in BIM as well as the adjacencies of departments and lifespan of a product such as doors, windows and flooring replacement.

"I think it would be clinical data, accident rate, recovery rate, it could be stored in BIM in each department in the room, for instance you could say in 2017 in that room the infection was registered. In terms of design, I think BIM is storing all information about design, if for example they want to replace a door it will be in the model, but I think the study should be how often that door or floor has been replaced. Adjacencies are important to know as well, we could put them as a template model in BIM, BIM could be an adjacency diagram" (Interviewee 8).

One of the designers said that there is no big difference between AutoCAD and BIM apart from 3D visualization of the project.

"It's not different from using AutoCAD or a drafting tool, only 3d. When the clients hand over the BIM model, you could put information into it, it's a 3d visualization of the project" (Interviewee 4).

While Interviewee 9 argued that BIM level 2 has not been reached yet as many companies claimed, and stated that the more you in-put the more you get from BIM.

"I don't think people have done BIM level 1 fully to get to BIM level 2, so actually information that you get is families and model, the more you can extract from is at the beginning, Solibri is a model where you get all clash detection, the more you put in the more you can use" (Interviewee 9).

Following his answer, he was asked a question about the reasons BIM level 2 has been not reached yet. He said there are lots of information that a limited number of people are working towards it, as it is a full model, yet not everyone shares, and he added that they are quite into it but not fully.

"Because a lot of information with a quite limit, people are working towards it, not everybody give the information you can deal with it is a full model. We are quite into it but not fully" (Interviewee 9).

Interviewees were then asked about the aspects of BIM they use. Three designers said that they do not use any aspects of BIM, as they do not use it, or because they cannot really envision the benefits of BIM use.

"No" (Interviewee 8).

"No I don't know" (Interviewee 1).

"I'm struggling to see the true benefit of it but I think it is mainly the coordination side of it" (Interviewee 12).

Four designers said that they use the CAD 'computer-aided design' aspect of BIM and the COBie 'Construction Operations Building Information Exchange' aspect.

"In terms of CAD, we use it for COBIE as well" (Interviewee 6).

One of them stated that they use everything about BIM and 'Navisworks'. In terms of BIM, coordination between the MEP 'mechanical, electrical, plumbing', which is a 3D design review package integrated in BIM that is very helpful in coordinating the MEP in their projects.

"We use all of it; Navisworks is helpful to coordinate the MEP" (Interviewee 13).

Another designer explained the process of using the BIM aspects by stating that they model the whole project in 3D, then use the model produced in order to create the schedule of areas, equipment, doors, ceiling and all technical and design details, which are then transferred into COBie drop. Then they coordinate it with all the models brought from the other disciplines such as M&E structure.

"We model everything in 3d, and then we use the model to produce schedules of areas. Schedules of equipment, schedules of doors, room volume, ceiling height, ceiling types, partition types, then export it to the Cobie drop and Cobie model, we bring in models from other disciplines, M&E structures models" (Interviewee 7).

One of the interviewees mentioned that they use BIM for everything, but using it does not mean that they achieved the accuracy in the project.

"We use it to do the full detail design of the project. When we don't have an existing building information it is difficult, and as soon as you have a 3d model, everybody assumes that the project is going to be 100% accurate which is not, BIM models are not accurate enough" (Interviewee 4).

Five designers said that they use Revit architecture in BIM.

"I try to use Revit architecture" (Interviewee 5, Interviewee 9 and Interviewee 11).

Another designer added "no I don't create information, but my team works with BIM and everything we produce comes through Revit software which is BIM. Our schedule are generated through a BIM model" (Interviewee 10).

Yet, one of the interviewees said that although they use Revit, they cannot use it in the beginning of the design process, as it limits their creativity and their design, therefore, they start using it at the second stage of the design, which is the technical phase.

> "Early stages of design we don't use BIM because it can be a little bit limiting as in Revit, there is a function in Revit called 'Enscape' which helps in visualising the project like 'SketchUp', when we start using Revit we will be at stage 2 floor levels, technical side, understanding department area" (Interviewee 2).

Two of the interviewees who are working for different companies said that they are already at BIM level 2 as shown in the following quotes

> "BIM level 2" (Interviewee 3).
>
> "We are in level 2 BIM, we work with Navisworks, Solibri and Bentley. The information in BIM and these platforms will help in developing the artificial intelligence" (Interviewee 14).

Interviewees were also asked about the extent of using BIM technologies to inform their design. Ten out of 14 designers said that they do use BIM libraries in their design, as some already have their own library within their practice.

> "We use that a lot, we already have a library of HC equipment, and parametric families which makes our life easier" (Interviewee 2).
>
> "The NHS ADB would be the example within that database, we use past projects, we have our own internal BIM library" (Interviewee 8).

Three of the interviewees mentioned that they use all libraries for HVAC, such as. 'Heating Ventilation Air Conditioning', 3D capabilities, in addition to carpentry and furniture (e.g. doors, windows, beds, sinks). Their quotes are as follows:

> "All the libraries, heating, ventilation, technical stuff" (Interviewee 1).
>
> "3D capabilities" (Interviewee 5).
>
> "Doors, sinks, and beds, and all what gives you the clearance" (Interviewee 13).

Two other designers conceded that the use of BIM makes their life easier and the parametric information are already set in BIM, which helps in avoiding the process of putting them in.

> "It does not really affect the design process, it just makes it easier" (Interviewee 4).
>
> "A lot of the families got parametric information in, I know most of the elements are there as well like doors, windows, wall type, screens and all generic wards, all best practice set up already in BIM so there won't be a repetitive process" (Interviewee 9).

Two interviewees explained their use of BIM, as one of stated that they have a BIM company that coordinates the whole design between all stakeholders.

> "Well, we have a sister company called BIM technologies, which is a BIM coordination service where we provide management and coordination so we collect models and drawings from other people to start with in terms of BIM libraries and knowledge which is another sister company called BIM star" (Interviewee 1).

The other designer mentioned that they use BIM and Revit models for the whole design.

> "The whole design, we do start with sketches but they are quickly modelled and we use BIM and Revit does 3d modelling and everything as well we can explore everything on the BIM model" (Interviewee 10).

Despite BIM benefits within the construction industry that have been explained by the interviewees in the previous sections, one designer said that they use BIM, however this one does not inform the design, besides of the heaviness of the Revit tool they use for their design.

> "We do but BIM doesn't inform the design, we use sketch up as a design tool, Revit although it's becoming slow and heavy" (Interviewee 3).

One designer suggested that a designed room within BIM could be helpful to use as a template, although they use objects like external walls, BIM helps more the M&E 'mechanical and electrical' engineers colleagues in visualizing the design and spotting where windows and ventilation could be placed as an example.

> "If we had a whole room that was done we could use that one better, but we do use objects like smaller external walls, not sure! We model in 3D it's easy to look at it, access of doors, where windows are, where slopes are, environmental aspects, it helps M&E colleagues more." (Interviewee 7).

The three remaining designers did not express their opinions regarding BIM and its use.

> "I do not know" (Interviewee 6, Interviewee 14).

One designer said that they could use the parametric inherently without using BIM.

> "We do use them; we probably do it inherently without using BIM" (Interviewee 12).

Designers were then asked about the automation of transferability of data from users to FM using BIM. One designer said it should be, although she was sceptical about it.

> "It should be, but I doubt it ever is" (Interviwee1).

While one said she does not know how to do it.

> "I don't know" (Interviewee 6).

Nine interviewees said that this could be possible, although there is a need for training in order to extract it and import the information in a BIM format.

> "I think it is but it needs more training" (Interviewee 5).
>
> "Yes but you need someone who can do it through BIM like a BIM engineer" (Interviewee 8).

Designers think that it is doable, as you can add some characteristics, while importing excel documents into Revit and use them as schedule recommendation.

> "I think we should be able to take it to them and add characteristics but don't know if it's easy" (Interviewee 7).
>
> "It is, we could import excel docs into Revit, and use them as parameters like schedule recommendation" (Interviewee 2).

However, the format could be critical, as most of them do not use BIM format.

> "Yes it could be yeah if you have the existing information to provide to us in a BIM format then we can use it, if they use Revit and export it to a file format then yes" (Interviewee 4).
>
> "Yes possible, but it's difficult to get DWG information from the client" (Interviewee 3).

Interviewee 10 said they need to convert the information received to BIM format.

> "It would be perfect if it was done automatically, but the information that we receive isn't always BIM compatible. So, we have to convert it or we take that information and build something. I suppose a good example would be working in an existing hospital building, Refurbishing projects and most trust don't have the estate model, so we have to commission somebody externally to provide us with the 3d survey or get us a 2d information and we will build the model from that which is time consuming. We usually don't receive information that is compatible with BIM technology and we have to do something" (Interviewee 10).

One of the designers said that they already have a database where they store all information in it.

> "We have a database we used to store all info in it" (Interviewee 13).

Another designer said that he does not know how to contain the information in BIM from users and FM, yet regarding the process where these data could be captured as soon as they have it.

"Where possible yes but I don't how to contain it; if I was talking about the process you capture the data as soon as you have it" (Interviewee 12).

Whereas three designers said that this could be great and time solving, yet it is not possible for the time being.

"I think it should be done auto but it's not like that for the time being" (Interviewee 14).

Architects are sceptical about the transfer of data from FM and users and the usability for them, yet it could be done for a new built, but not an existing built as they do not have BIM compatibility with the project.

"I don't know about automatically, I think it will get there eventually. In terms of FM and users, we can put Cobie and Cobie codes and all sorts of thigs we can extract the model but don't know how usable it is for the FM at this time. Bu it will become more and more used" (Interviewee 11).

"If you work on an existing building you don't have any information on a BIM format, and if it's a new building and they want to change the flexibility of the space since it happens, it can't be doable on an existing building because of the model that not BIM format" (Interviewee 9).

Following this question, designers were asked about the aspect of feedback they need from users and FM in a way it could be stored in BIM. According to designers, feedback should be recorded and noted on drawings, although the process needs to be continual between FM, users, and the design team, which is an issue as they rarely interact.

"Clearly, if we have a user meeting, it's all recorded, on drawing forms and records notes and transferred to the design development team. If we do a clinical user meeting, we should discuss with the FM providers and I guess the process should have a continuity. Problems of communication between all teams, architects and FM and staff is another issue" (Interviewee 1).

Two interviewees did not understand the question.

"I don't know" (Interviewee 6 and Interviewee 14).

One designer said that they need feedback of the space and things that do not work in it.

"Feedback of space and things that don't work" Interviewee 5.

Two designers said that it could be on spreadsheet or excel, although one designer said that she does not really know the best way to import it as it could be based parametric object or excel.

> "I do not know because I don't know the best way to import it, whether it's based parametric object, whether it's based on excel spreadsheet" (Interviewee 7).

> "Excel or spreadsheet base then we put it into the BIM container" (Interviewee 12).

The transfer of data would be helpful if it is an existing built.

> "If it's an existing building, it would be helpful for us but not the new built" (Interviewee 3).

Interviewee 8 said that they receive written documents or a Revit model.

> "Currently it would be written docs, it could be a Revit model provided to us" (Interviewee 8).

Interviewee 2 noted that the transfer can be done, as they already captured data about equipment from users and stored it, however they used a different tool that interacts with Revit called 'Codebook', which helped in recording what changes have been made on the project that users can have access to.

> "It could be, we already captured data and stored it from users about equipment, but we use a different tool that communicates with Revit, that users can have access to, and that tool can record at certain times what changes have been made by who and for which reasons, so history is stored somewhere called Codebook" (Interviewee 2).

Interviewee 13 added:

> "A lot of information can be on their preferred finishes that they want to use for FM and these info go for the requirements of the room".

Still the problem is the compatibility to BIM format as clients have information about the project; however, they do not use BIM and to convert the massive information given is not easy.

> "A lot of information can't be BIM compatible for example the Brief aspiration for the building that has to be in a written form. However, certainly the area schedule and the existing building information could be in BIM but usually is not. Because it is provided to us by clients, but they don't. They have a lot of information and to actually convert their massive information is not an easy task" (Interviewee 10).

Finally, two designers added that BIM execution plan helps in running the estate and to be able to get data and information about the estate, users have to dictate to the design team about the process of functionality of it.

"I think it's for them to dictate to us, they are running their estate and I don't know what the estate is which is where the BIM execution plan comes in. in terms of running the building I think they would know that there would be a gap in the knowledge" (Interviewee 11).

Interviewee 4 said that it could be beneficial for everyone to spot the clashes and problems of the project on a tablet, which the client can use and the tablet is accessed by the design team.

"I suppose the clients would have a tablet when they have a problem, they click on the wall, on the room, on the location of the problem, and when they do this the estate team knows about it. If it's linked to the staff base and they have where to report and say where the problem is it could benefit everybody" (Interviewee 4).

Designers were then asked whether geometric or non-geometric data, would be more helpful to them, hence seven designers opted for geometric data because of its importance in the coordination and the visualization side.

"It would be the geometric" (Interviewee1)

"Geometric" (Interviewee 3)

"It would be the geometric stuff because it's the coordination thing that everybody is looking for. For us the geo is more important to us. For no- geo, the stuff would be cost information and this will not make it a difference for us" (Interviewee 4).

Four designers added:

"I like to see things visually so geometric" (Interviewee 7).

"From our side geometric I would say more than non geo" (Interviewee 9).

"The geometric is important" (Interviewee 10).

"It would be the geometric from my point of view" (Interviewee 11).

Five designers said that the non-geometric data would interest them more than the geometric because of its value and usefulness, and their importance to the project.

"Non-geometric is useful" (Interviewee 2).

As geometric data are known and learnt through experience and knowledge, whereas non-geometric data is not known for designers and it would be a great bonus to have.

"Non-geometric will be more valuable, we inherit knowledge of the geometric, but the non geo we don't know them until somebody tells us" (Interviewee 8).

Two interviewees added:

"I believe non-geometric. Because if we had costs, acoustic information and other non-geometric it would be great" (Interviewee 14).

"I would say non geometric, we know the geo but the non geo is unknown" (Interviewee 12).

One designer said that both data are important but she would prefer non-geometric data.

"Both but I think non geometric because we already have geometric data" (Interviewee 13).

Two more designers did not choose any of the data as one said "I don't know" (Interviewee 6), and the other said that it depends on the stage of the project "I think it depends on what stage you are and what you are doing" (Interviewee 5).

5.3 WARD-RELATED SPACES AND THEIR ISSUES

G/ OPTIONAL QUESTIONS

Two interviewees said that there is less communal space and that they do not see it important.

"I think no" (Interviewee 6); "there are less communal space" (Interviewee 8).

However, most designers emphasised the importance of communal space. They argued that this may depend on the type of ward, the type of patients and their case if they need to be allocated to single ward or communal. Their quotes are as follows:

"Yes" (Interviewee 3)

"It depends on the specialty of the ward" (Interviewee 13).

"Of course it is, but depends on the ward, because there are wards that need to have people around and other wards that don't need to be collective depending the patient case and how the trust want the medical clinical staff to manage" (Interviewee 1).

Interviewee 1 shared that she has been hospitalised herself in a ward that was not clean and used mainly by visitors, not enlighten enough, she thinks that this could be a management issue.

"I have been in a ward not clean and used by visitors, dark, misused, and eventually turned out into a visitor's waiting room. The problem was a management issue" (Interviewee 1).

Three interviewees added that this is part of the brief and should be required by the client.

"I think it depends on different people, it's valuable" (Interviewee 2).

"Yes, mainly it's an area under brief" (Interviewee 7).

"Yes, requirements of the clients" (Interviewee 14).

Amongst the criteria that should be taken into consideration in the design of communal space are the lighting, accessibility to fresh hair and views, use of appealing colours, aesthetic side of it, besides the comfort, the flexibility of the space and its functionality.

> "Softer lighting, access to fresh air, a good view, use of colours" (Interviewee 2).
>
> "When you come to the ward you want it to be warm and welcoming. It is very important to get it. The criteria is a beautiful and comfortable, easy to understand, the staff being able to move around, the flexibility of the space, warm and welcoming" and Interviewee 8 "the circulation basis are important" (Interviewee 4).

Furthermore, privacy and dignity, along with furniture are crucial in the design.

> "Yes, choice of function and spaces, Light and privacy, furniture and function" (Interviewee 5).
>
> "Yes. Criteria are Privacy and dignity, the medical needs and comfort, everything is important you need to keep the balance" (Interviewee 9).
>
> "It's very important, it should be as domesticated as possible, the floor type, the access the views and everything that makes it feel like a home" (Interviewee 12).

One of the designers explained the process they go through for the design, as they start with design guidelines (e.g. HBNs) then liaise with the client and check whether there are further requirements in the brief.

> "Yes. Criteria, every health building has an HBN that is the benchmark standard. Therefore, we always use that as a starting point then we liaise with the client if they have any bespoke requirements for the brief. If there are any other external parties who want to use the building, we consult with them. As well, we might introduce additional statutory guidance, which they need to be aware of and building regulations probe to that space. We then look at the colour guidance for the interior design and if there is anything that affects badly the patient state for example dementia. There are a lot of guidance we look at the design" (Interviewee 10).

Interviewee 7 said that this information regarding the criteria like functionality and welcome side cannot be captured in BIM.

> "So you want to make both things welcoming and functional. I don't know if you can capture this in BIM" (Interviewee 7).

Interviewee 11 said that it is important to have the design of communal space criteria incorporated in BIM.

> "I think there is an element of importance in BIM having communal areas depends on the person they will keep in that room, if people don't get visitors they need to get in

multi bed bays. The criteria we think of orientation towards the light and furnishing" (Interviewee 11).

Apart from one designer who did not express his opinion about the priorities of wards "I don't know" (Interviewee 14). Four designers said that all wards should be equal in the design, as none of them takes the importance upon the other. Their statements are as follows:

"Yes all important" (Interviewee 3).

"I think they are pretty much the same" (Interviewee 5).

"All of them are supposed to be created equal. Our brief is to make buildings flexible" (Interviewee 7).

"They are all equally important. They are all highly technical and I think they are same" (Interviewee 10).

One designer said that the difference could be in expenditure as some wards may necessitate more money than others do; however, no priority is noticed in terms of design. Besides, the technical side and the colour used in the space, there should be no priority in designing them.

"I don't think any of them should take priority, all of them need attention as much for the staff as for the patients. It should be equal, I know the money could be spent on some more than others could, but in terms of design, there is no priority. Regarding the challenge, children's ward, ICU ward. When you go to ICU, they are very technical although you keep considering colour of the space and other design details. I don't think there must be an order for the priority, they are all important, and you take everything you can to make them best spaces, that's what architects is about solving problems. I think the very technical areas ICU, theatres, cardio are more of a challenge but generally, wards are not really difficult in design although some could be very miserable" (Interviewee1).

She also added that these information, should be in the brief prior to design and that not only designers need to do POE but clients as well with the patient group.

"The client should be aware of the patients group prior to the briefing that what POE is about. Not only should the design team do the POE but clients as well" (Interviewee1).

Nevertheless all wards are difficult, one designer pointed out that the technical and particular ones could be harder.

"It's hard to say this because all of them are difficult to do, especially when you have particular ones and technical" (Interviewee 4).

Seven interviewees said that the specific ones are more difficult than the generic ward such as paediatrics, ICU 'Intensive Care Unit', emergency department, oncology unit, psychiatric unit. Their quotes are as follows:

> "Specialist are hard and difficult to maintain" (Interviewee 2).
>
> "Some are specific" (Interviewee 6).
>
> "There are all different and have specific requirements and have to work together" (Interviewee 8).
>
> "I think paediatrics are important because families stay in the ward as well, and in terms of adults its fine they don't need more space" (Interviewee 9).
>
> "The critical unit and some specialist wards, emergency department, oncology unit, psychiatric unit" (Interviewee 13).

Difficulties of designing ward could vary depending on the speciality of the ward, as each department has challenges.

> "In terms of difficulties, each depart has its challenges. And depending on the function of each ward" (Interviewee 11).

This could also depend on length of stay in the ward.

> "I think it depends on length of stay, surgical ward would have a lot going in there, oncology ward as well". (Interviewee 12).

Most interviewees said that they do not include space for relatives in patients' room, unless it is part of the client brief and their requirements.

> "Depends on the client brief" (Interviewee 3).
>
> "The client will tell us" (Interviewee 14).

Two interviewees said that it might also depend on the type of patients and the staff needs.

> "They do not get space in the ward, and it depends on the type of patients" (Interviewee 4).
>
> "If there is a requirement we need to add more space in the schedule area, there are standard layouts where we add space and others not and we present this to the client. We need to review the brief and ask the clinical staff to see whether they need it or not" (Interviewee 10).

Yet, Interviewee 13 said that it is already part of the room "It is part of the patient room". While two designers talked about single patient rooms, and affirmed that they are better than multi-bed bays. One of them explained that wards are becoming more single patient rooms than multi bedrooms, which is good for children but not for adults as they need to interact

with each other due to loneliness issue, as their family relatives might not come to visit. Their quotes are as follows:

> "Single bed work more than multi bed bays" (Interviewee 12).
>
> "You know more and more wards are becoming single patient rooms apart from children. I think the older patients ward should be in a multi bed bays because they need to talk to each other and their family members might not come. You have to be genius to solve the problem of space" (Interviewee 1).

Seven interviewees said that they do not provide space for relatives in the patients' room.

> "We don't offer space in single bedrooms for relatives" (Interviewee 2, Interviewee 5, Interviewee 6, Interviewee 7, Interviewee 8, Interviewee 9 and Interviewee 11).

5.4 PRIVACY VERSUS OBSERVATION ON WARDS

Another important question discussed by healthcare respondents and designers was the balance between observability and privacy. That is to say, designers need to design a comfortable environment for users (staff and patients), where there is a possibility for staff to observe patients and keep a constant eye on them for their security and safety and the privacy of patients that is highly required. Three interviewees did not answer this question.

> "I don't know" (Interviewee 3, Interviewee 6 and Interviewee 12).

The eleven designers have shared their knowledge in terms of keeping privacy and observation at the same time by saying that it could be with using panels.

> "There are all sorts of different ways to monitor; it could be a CCTV 'closed-circuit television', a viewing panel, you have to check constantly on patients, that's why nurses like multi bed rooms because they can manage it even if some patients may hate and close the curtains for their privacy. Personally, I think there should be a panel" (Interviewee1).

Two other designers added:

> "Various ways you can do it, mostly its vision panels. This is a difficult one!" (Interviewee 7).
>
> "Panels probably" (Interviewee 14).

Other interviewees suggested the use of windows built into doors, blinds or screens. Their quotes are as follows:

> "We have glazed screens that have blinds integrated in the corridors, and we think of the head bed orientation to keep privacy" (Interviewee 2).
>
> "We could do it with screens" (Interviewee 5).

"Windows built into the doors, so the staff can look from the windows" (Interviewee 13).

One designer suggested putting blinds in the room and outside the room, so patients can control privacy from their side and staff can observe them; however, if patients close it from the inside then staff lose control, which is why using polarised glass or blinds inside the glass can minimise the spread of infection.

> "Blinds on both sides so patients can control privacy and staff can monitor, the problem if you get control on one side only, the simplest way is to do a polarized glass, or blinds inside the glass to minimize infection" (Interviewee 9).

Interviewee 1 said that hospital is not a hotel and patients should not require privacy as it is for their benefits to be observed

> "It is not a hotel it's for patients and their safety they can't demand privacy, because it's part of the treatment and patients need to be realistic, they are there to get better and one way is to enable staff having an eye on them. Your life changes in a hospital it is not like you are at home or in a hotel" (Interviewee 1).

She and other designers also added that this privacy and observation process should be captured in the design guidelines such as HBNs, HTMs, ADB and need to be updated.

> "Well it should be capture in the health building notes, and should be captured in one issue of the privacy in BN called privacy and dignity archived and needs to be revised. There must be a serious discussion about the privacy to allow full privacy to constant monitoring" (Interviewee 1).

> "We put suitable glasses, integrated blinds within the system. We speak to the clinicians and we know where to put the panels. It should be kept in HTMs, there should be a place, to put information, ADB, although the update is not very often" (Interviewee 4).

This issue could be solved as well by centralizing the touch down stations and reduce footfalls, also by installing IT equipment in the right place, without forgetting to capture it in P21 'ProCure21' and P22 'ProCure 22'. However, not everyone is using P22 and this could be an issue.

> "Privacy and dignity is high on the agenda, you can centralize stations to reduce footfalls, IT equipment and technology has its place, so you can monitor the patient without being on top of them. It should be captured nationally, in a learning global team like P21, P22 but that is limited to the people and contractors who are in the

framework. Everyone's working in hospital is not necessarily contracting with P22" (Interviewee 11).

One of the designers said that it could be a management and financial issue, as they cannot afford to have many staff on the ward, yet it could be solved by well managing; however, the use of CCTV is not recommended, as it is not legal to use it.

> "The easy answer to employ more staff, since one nurse cannot monitor all patients. In terms of design, we have to design for observation for a limited number of staff. In terms of design (laughing), what we can do is to incorporate screens with blinds and observe from touch down station. We cannot use CCTV because of legal issues. I think it's a question of finance, if we could afford more money we could do more things…" (Interviewee 8).

Finally, one of the designers said that a solution to address this problem could be the use of electronic glass that is transparent and placed on the wall by clicking on it, it becomes white; however, the problem of cost arises as clients are not convinced about it, yet it is cheaper than the integrated panels.

> "All of the spaces have to be observed either glaze windows or window panels. There is a reduction in the blinds and the screens. Now we are using electronic glass it is transparent and we click on it so it becomes white, still depending on the brief and budget. We record the cost data for that system (electronic panels). Actually, the integrated panel costs you more than the digital one but the client doesn't see the value of it. The cost information are important when you intervene with new solutions" (Interviewee 10).

Designers have been asked about further issues in terms of designing hospital wards. Seven out of 14 designers did not add any issues.

> "Nothing else" (Interviewee 2, Interviewee 3, Interviewee 4, Interviewee 5, Interviewee 6, Interviewee 12 and Interviewee 14).

The seven other designers mentioned few issues related to the design, such as space issues and the compliance to building notes and the derogations, besides of lack of spaces allocated to relatives, playrooms, day rooms and storage space.

> "well, it is the space issues and the insane BN and derogation issues, the space allocation about relative rooms, day rooms, play rooms, storage (massive problem) because always it's reduced" (Interviewee 1).

In addition to the connection to nature and views out from the room as well as the privacy.

> "It's important to get rooms a view out, and a connection with the nature, privacy as well should be considered" (Interviewee 7).

Interviewee 7 was further asked following her answer, about the feedback whether it is more important than tacit knowledge or not. She responded that they are complementary and tacit knowledge can fill the gap of lack of feedback

> "They are complementary, because if we don't get enough feedback we refer to tacit knowledge" (Interviewee 7).

According to some designers, isolation in single rooms could be a problem for the psychological side of patients that affects their recovery.

> "Isolation could be a problem" (Interviewee 8).

Interviewee 10 pointed out that the hospital design changed from multi bed-bays to single bedrooms. However, the staff are not happy about it, as it makes it difficult for them to supervise patients in the ward according to their feedback in POE, and that this may change in the 5 or 10 years to get back again to multi bed-bays.

> "There is an interesting debate that is ongoing that concerns the design of wards. We moved from multi bed bays to single bedrooms. What we get from POE, the clinical staff have to supervise the wards, they want to move from 100% single bedrooms to multi bed bays, and it is probably going to change in the 5 to 10 years. There is a lot suggesting the isolation in the single bedrooms, which is not good for the psychological side" (Interviewee 10).

Interviewee 10 also added that the client aspirations are important in the design because of their perception of the environment and its functionality, in addition to the schedule of accommodation and adjacency matrix that help in getting the design done.

> "The most important in the data is schedule of accommodation and adjacency matrix because we can't develop the design without it. Therefore, I think it is the basic requirement for the building. Client aspirations and how they see it if it's functional or need to be improved and the like" (Interviewee 10).

Two designers talked about the protocol of evacuation and the accessibility, as well as the way doors are managed, as it could be an issue for circulation. This was supported as follows:

"Door control, how to access it, the door management system is a bit of problem and it's meant for circulation, evacuation in a case of fire, fire control, access control, evacuation control" (Interviewee 9).

"Fire is always a little bit down the list, evacuation should be considered" (Interviewee 11).

His answer was followed by a question about the kind of data that should be captured. He said that data are already in the design guidelines that are doomed down, yet he thinks that it is a great thing because of bureaucracy, hence reducing knowledge base. Also, he suggested that a great idea is to capture feedback and store it in a generic departmental feedback that is disseminated afterwards.

"A lot of the data are there in the HTMS and HBNS, doomed down which I don't think it's particularly good but the idea is to reduce bureaucracy, which is a reduction in the knowledge base, that data is already captured but I think it could be useful to get. It would be interesting to get departmental feedback but more generically and disseminated so we can get trends for the design data" (Interviewee 11).

Finally, these designers clarified that the design should be done efficiently and to their best knowledge in order to provide a great and functional environment for staff and patients.

"The design to make it the most efficient and the best place to work for staff and the best environment for patients" (Interviewee 13).

5.5 SUMMARY

The design of healthcare facilities is an important factor that helps in the process of patients' healing but prior to the ward design, there is a necessity of awareness from designers regarding the issues in the ward such as nursing and their workflow. Architects/designers emphasised the importance of feedback that has an impact on the design. According to them, the healthcare users (i.e. the medical and nursing staff, patients and visitors) and facility managers perceive the design of healthcare premises differently according to their use and needs.

In the opinion of the majority of designers who clearly demonstrated that HC users are the most important ones in getting feedback from as they inform them of the functionality of the building and the relationship between departments, who are then followed by facility mangers then patients and visitors. Despite the importance of HC users and their views as they use the building on a daily basis, FM are still important as they are the ones who maintain the building and help in avoiding the same mistakes through the whole building

lifecycle. The three categories are important and complement each other while creating a good and balanced environment fit for purpose for all users. However, patient and visitors' feedback is hard to get because of ethical and confidentiality reasons, otherwise is missed due to the long process of getting it. Nonetheless, designers explained that the patient representative' group may be involved sometimes during the design process and give feedback; there is a risk for their feedback to not be taken in consideration as it could be a management issue. Designers emphasised the importance of getting feedback from the FM team, who can provide them with a brief that covers the ergonomic requirements related to the space requirements such as the area schedule, adjacency matrix, and materials choice. Moreover, they could offer a policy statement for each department such as fire and management policies.

Furthermore, HC team and FM users' opinion is important as feedback received could be from a personal point of view in terms of experience or could be pragmatic in terms of personal choice. As wards are not general all the time and most of them are specific, the feedback received needs to be specific. All wards should be equal in the design, as none of them takes the importance upon the other but the difference could be in expenditure as some wards may necessitate more money than others, while in terms of design no priority is noticed. Besides of the technical side and the colour used in the space, there should be no priority in designing them and these information should be in the brief prior to design and that not only designers need to do POE but clients as well with the patient group. Nevertheless all wards are difficult, the technical and particular ones could be harder. The specific ones are more difficult than the generic ward such as paediatrics, ICU 'Intensive Care Unit', emergency department, oncology unit, psychiatric unit. Difficulties of designing ward could vary depending on the speciality of the ward, as each department has challenges. All users should be involved to share their feedback, however because they do not get it all the time, feedback is not captured, therefore it is impossible for them to build a meticulous and rigorous feedback input for future projects.

According to designers, facility managers do not get involved at the early stages of the design, which leads to missing the feedback at an important stage leading to unexploited knowledge. Yet, FM feedback tend to be conflicting at times as they keep changing their feedback during the whole process, which contradicts the design guidance. The data designers get from the FM is the lessons learnt from their previous projects that help them in

avoiding the same mistakes related to the manufacture for e.g. ceiling. Prior to the concept design, if architects do not get feedback from clients, they generate it in their practice, given that it affects the design with 15%. Nevertheless, the design without the FM side would be incomplete as they are the ones who provide information about the project such as the standard equipment list, which they review and discuss in case it gets changed, yet designers do not get a huge feedback and all necessary information from them. Although, there are information designers do not get such as environmental behavioural and feedback from HC users, they still refer to their best practices from their previous projects. Knowledge and conversation from users' engagement could be helping in the design process. However, FM is neglected in the process, as they do not get involved in the beginning of the process, which makes it difficult for the design team.

Some issues cannot be dealt only from the FM side such as the collection and treatment of medical waste, but mainly as a management issue. Feedback is sort of knowledge and experience, which is in a centralized system within the practice where all designers' ideas and knowledge are stored. Feedback could be reused through dialogue and conversation between designers and clients about the designs that worked and the ones that did not work. Feedback and tacit knowledge are complementary and tacit knowledge can fill the gap of lack of feedback. According to designers, feedback should be recorded and noted on drawings, although the process needs to be continual between FM and users, and the design team, which is an issue as they rarely interact. Amongst the problems designers encounter is the multiple meetings they have with clients and the change of feedback they get every time they meet. The criteria designers follow in the design of adults' inpatients' wards is the functionality of the space, the aspect of the room, providing a comfort environment for patients and staff. In addition to the length of stay on wards, dignity, infection control rate and observation and privacy that are critical to balance.

Furthermore, designers like to focus on daylights, patients' safety, access to staff and views outside, visibility to monitor patients, travel distances, room layout, natural ventilation, access to bathrooms, changing facilities for staff, break rooms, way finding, area size, lights in the corridors, medical gases, flexibility of the space, and room adjacencies. Getting feedback from users could be a potential to be aware of the requirements. The designers could need some requirements from the clients, which could be a schedule of

accommodation, the list of equipment they use on ward. In addition to the choice of materials and products, and from the HC team it could be the services such as X-rays and scans, however in case these information are not received then a back up to knowledge and experience is necessary. The useful data or information designers get in the design of hospital wards from FM and healthcare 'HC' users are about the space whether it is adequate or not and from the FM team about materials and their lifespan. There is less communal space and designers don't see it important depending on the type of ward, the type pf patients and their case if they need to be allocated to single ward or communal, but could be part of the brief and client requirements. Amongst the criteria that should be taken in consideration in the design of communal space are the lighting, accessibility to fresh hair and views, use of appealing colours, aesthetic side of it, besides of the comfort, the flexibility of the space and its functionality. Moreover, privacy and dignity along with furniture play an important role in the design. Designers need to design a comfortable environment for users (staff and patients), where there is a possibility for staff to observe patients and keep a constant eye on them for their security and safety and the privacy of patients that is highly required.

Balancing privacy and observation at the same time could be with the use of panels or use of windows built into doors, blinds or screens, besides of blinds in the room and outside the room. Hence, patients can control privacy from their side and staff can observe them, however if patients close it from the inside then staff lose control, which is why using polarised glass or blinds inside the glass can minimise the spread of infection. This issue could be solved as well by centralizing the touch down stations and reduce footfalls, also by installing IT equipment in the right place, without forgetting to capture it in P21 'procurement 21' and P22 'procurement 22', although not everyone is using P22 which could be a problem. It could be a management and financial issue as they cannot afford to have many staff on the ward, yet managing well could solve it. There could be a solution for this problem, which is electronic glass that is transparent and placed on the wall by clicking on it, it becomes white; however, the problem of cost arises as clients are not really convinced about it, yet it is cheaper than the integrated panels. Privacy and observation process should be captured in the design guidelines such as HBNs, HTMs, ADB and need to be updated. According to designers, geometric data is more important than non-geometric because of its importance in the coordination and the visualization side. Yet, non-geometric data would be interesting to have because of its value, usefulness and importance to the project. As geometric data are known and learnt through experience and knowledge, whereas non-

geometric data is not known for designers and it would be a great bonus to have. An important tool is considered by many designers to get the data needed for the design of wards is post occupancy evaluation 'POE'. Designers pointed out that sometimes the brief might lack information, which they can fill the gap with their experience, knowledge, previous project benchmarks and guidance. Hospital design changed from multi bed bays to single bed rooms, which is good for children but not for adults as they need to interact with each other due to loneliness issue as their family relatives might not come to visit. However, the staff are not happy about it as it makes it difficult for them to supervise patients on ward according to their feedback in POE. Additionally, the isolation in single rooms could be a problem for the psychological side of patients that adversely affects their recovery. However, this may change in the five or ten years to get back again to multi bed bays.

Designers explained that they get negative feedback from staff and patients regarding the single rooms' layout, as they prefer to be more in multi bed-bays, which are getting less common in wards. Yet, single rooms have more advantages than multi bed bays such as the recovery time, cleaning process, infection control, comfort and good insulation. Designers refer to the design guidelines as a benchmark during the whole construction process, which include HBNs 'Health Building notes', HTMs 'Health Technical Memoranda'. Design guidelines such as HBNs and HTMs and health architectural site can inform the design, however they are not specific and not provided at the early stages of the design. Designers can model from the ADB 'Activity Database' for the department of health, yet not everything can be designed through design guidelines due to the specificity of the building. Designers start using HBNs, HTMs and ADB as a starting point of design and basic principles then liaise with the client and check whether there are further requirements in the brief. The brief could be generic or specific depending on the clients and their requirements as it could be heavily contractual. Designers cannot rely on design guidelines only (e.g. HBNs, HTMs) because they have not been updated for more than 10 years. This means that learning never stops and the more they learn the more knowledge they acquire. However, information regarding the criteria like functionality and welcome side cannot be captured in BIM. It is important to have the design of communal space criteria incorporated in BIM. Designers start using feedback from healthcare users and facility managers during the early stages of the design and in other cases it could be during the stage 2, which is developed design because designers need to know the function of the building before involving users. In terms of concept design, designers involve HC staff and clients to get feedback and an initial brief

from them that is developed prior to the concept design then developed to the schematic design with more details. Facility managers are involved afterwards to help designers know the material choice and the lifecycle replacement. Yet, the feedback is used throughout the project, which can help in reducing the footfall and having an idea of the functionality of spaces on wards. The tools designers use to capture the feedback is either verbal, notes or mark-ups on the drawings. These several feedback are reused by implementing them afterwards in other projects. In addition to the drawings' mark-up and the POE format, meeting minutes is another option to get feedback from users as well as photos, notes and VR 'virtual reality' that helps in the meeting to visualize the space. Moreover, a design decision matrix is created by designers that is a schedule of recommendation used along with the room datasheets.

Furthermore, a tool called BlueBeam, which is a grown-up version of pdf and used by designers where they can project on the screen and use it to capture feedback by drawing upon it and making comments that are translated into Revit models. Designers suggested that having workshops where people can share freely their feedback and opinions about spaces functionality would be great that should be scanned and stored later on in their database and reused through meetings and exchange. In addition to the traditional way of doing, designers also use a spreadsheet with comments that is easily manipulated, however retrieving it is hard as not everyone is aware of the placement of the projects and the type of data stored. Designers emphasised the importance of POE that helps in getting feedback and facilitates the task of designers who store electronic records of the meeting notes and scanned briefs. It is clear from designers' point of view that POE is part of the process to capture feedback that is stored in a knowledge base. Moreover, people' experience are valuable and need to be captured where they can have a learning exercise to drop feedback in the knowledge base of components. Although, it is not easy to share knowledge, as it may vary from generic to specific, indeed POE, lessons learnt and the decentralization of information is necessary. Designers talked about the unexploited data that could be about the way of cleaning the clinical spaces from the FM side, as well as the ground conditions.

The additional data needed could be staff feedback and patient outcomes as the design is built for them and having their feedback could help in improving the design, hence their state.

They explained the reasons for which they are unexploited due to financial, political and timing reasons. In addition, the opportunity of speaking to everyone is not available. Facility managers do not get involved in the early stages of the design because they like to see

tangible results physically rather than technically. There is an issue of timing as designers may ask for information regarding the design and the materials used, which come late on site, yet the client still asks for it to be implemented. The missing information that lead to failure in the design are about material selection and technical design related such as wall and ceiling finishes. Moreover, clients do not attend the meetings highlighted by designers due to their schedule, which leads to unexploited data due to time constraints. One of the designers clarified that, existing built could be a challenge as they need to know the adjacent departments, hazards and risks associated to it and if it needs to be changed. The reason for which data could be unexploited is the way it is stored as it could be lost within a month time. In addition to the way information are not centralized and could be vague, as management of feedback received is another issue as all stakeholders would like to share their opinions, which they need to be well-managed otherwise designers would get overwhelmed with the information that will be lost. Designers argued that the data should be available on time, so they can have a clear view of the site by incorporating it at the early stages of the design, documenting it, standardising explicitly and sharing it.

The data could be about transports, patients' body, staffing and finances, but without these information, the business case is insufficient and designers need to have more realistic approaches. Moreover, designers need to understand the whole process and the way it works, as the more data they get, the better solutions they achieve and feedback. One of the designers suggested that they could model scenarios to get an understanding of the data that inform them about the environment and the impact it has on patients, and how ventilation can work. Knowledge has to be shared amongst stakeholders and get incorporated in a knowledge bank. According to designers, the data that would inform better design could be the exploited as it is necessary to have in order to help designers in their project, while the unexploited could be gained through experience and knowledge. Although knowledge could be captured in BIM format with a constant update, knowledge sharing is not easy due to cultural differences. The information needed could be about the project governance and procurement, as designers cannot start designing a project before looking at the procurement.

According to one of the designers, unexploited data may lead to innovation and both exploited and unexploited are equal and they do influence the design scheme; however, possessing the unexploited would be a bigger impact. He also gave a percentage of 50% each if they knew about the unexploited, otherwise 60% per exploited knowledge and 40% per

unexploited knowledge if they did not know about the unexploited. Despite all data are valid, one designer argued that exploited data would help better in the project. The choice of data depends on its availability, as it would be well received; however, a delay in getting it would lead to changes in the project hence shortfalls, which is why exploited data informs better design-decision making. One designer said that although the exploited would be good, and the gaps could be filled by going back to the clients to ask them for more feedback, the unexploited are more important as they cost more. Another designer said that the more they get information, the more it is better for the project. Indeed, getting information on time and sharing it would be better used, as well as spending more time in building the brief would help in exploiting the data better, however engagement from the project managers part would be great in sharing information about the project such as ground conditions as they do not get all information regarding it. The challenges of getting or receiving feedback could be management, financial and time constraints.

In addition to contractual issues that leads to loss of information as it takes a long process to get the information from the main person. Furthermore, the accessibility to the information in the right place and time as well as the right people could be challenging. Another barrier to get the feedback is due to the confidentiality of information. Accessibility to providers of information and its quality as well as the programme is another barrier. The data designers receive is stored either in the brief or minutes. It is difficult for designers to get feedback from users in a POE format. Information can be transferred to designers in several forms such as written forms, paper documents. Design information can be stored in a project folder in the system the company uses; however, everyone in the company should be aware of the type of information stored and its placement. Furthermore, information could be stored electronically in a healthcare library. Interviewees explained that they create a set of drawings, which are shared with the users during the meetings by capturing the key points. They further stated that hey constantly learn from their previous projects, in other words they use the lessons learnt stored in their healthcare library accessible to all offices in that firm, which they retrieve through diagrams and sketches in a visual format. Getting information from facility managers is hard but designers can get it from the trust since facility managers, deal only with the health estate team, and information is retrieved from their digital library.

Feedback inform the design better where designers store it in a healthcare database in their company. Data is captured through meetings in addition to the business cases, project records and feedback outcomes from the client either facility managers or clinical team. Information is stored traditionally in files by the design team and the concept lead. Designers try to keep

the data received from the clients for a minimum of 12 years, as each project has its own electronic file, and feedback is stored on a specific file. Moreover, post occupancy evaluation 'POE' is another mean of getting feedback, as well as having a constant contact with clients on a long term-relationship, the feedback is electronically stored in record machines, which is lessons learnt; these ones are represented by personal track of the project noted on notebooks or electronically filed. Designers suggest they centralize the data for the trust for the client; however, clients are not always the same end-users, as one hospital may have a private finance initiative and a non-private finance initiative hence the strategy needs to change. From the facility managers, technical feedback is necessary that is related to HVAC 'Heating Ventilation, Air Conditioning', and from clinical team it could be regarding the scans and MRI 'Magnetic resonance imaging. Designers retrieve data through research, reading and talking to people; this data will be then stored manually and used if necessary. Although designers are not familiar with the terms of tacit knowledge and pattern language, they still use it for their projects. All of them emphasised that they get their tacit knowledge from experience, sharing the knowledge among colleagues, learning from past projects, and referring to the design standards such as health building notes 'HBNs' and health technical memoranda 'HTMs'.

In addition to networking while going to conferences for learning, continual professional development 'CPD', reading constantly and visiting the buildings for the observation side. Designers noted that it is important to work in the healthcare sector field to acquire knowledge, besides of the exchange between people. Designers made a conclusion by stating that their knowledge comes from lessons learnt and explicit knowledge, which is accessible in books, manuals and written documents through reading the explicit knowledge, which is acquired and transformed into tacit knowledge then disseminated again to explicit knowledge is a sort of cycle, where both tacit and explicit knowledge interact with one another. Information and knowledge could be passed on and shared among colleagues verbally, and space planning could be shared. Designers said that it is possible to do but they do not know the type of tacit knowledge that should be captured, yet the sharing is important and should be done on time. The context needs to be captured contractually, in order to be used explicitly by users.

The more there is engagement from people the more they get information. Someone needs to be appointed to manage the knowledge in the practice, which comes from POE initially that has to be stored in a knowledge repository and used in future projects; "it should be yes. Tacit

knowledge; any form of Poe is important, we have that on-going debate in the office and we are looking to appoint somebody to actually manage and improve the way we do convert our tacit knowledge into our explicit knowledge at the moment. This is about research need because most of that comes from research need and POE could be very good at collecting. Although some practices already, have a system that helps in storing the knowledge that could be the design standards as HBNs and HTMs and building control. However, the person who needs to upload the information into the system should have an architectural background or at least be aware of the project and the details to insert. Another designer confirmed this by saying that it is first a funding problem of capturing and storing knowledge on a regular basis, and second time and management issue as it requires people to do it. They could also capture users' opinions about the space, which is hard to get as it is personal perception but BIM is a great tool to do this, which needs more investment, research and commitment. From the findings, all the interviewees 'Designers' are aware of BIM and the benefits it brings to the industry. Most of them use it and noticed its benefits. Designers use BIM on their day-to-day task, yet as mentioned by them that there is a need for a BIM specialist to get more benefits from using it.

Interviewees pointed out that getting a standardised room within BIM model can facilitate their task and makes the process faster, because there are drawings that do not constantly change such as toilets, patient rooms, clean facilities, staircases and corridors; clinical spaces can change but other spaces like corridors should be fixed in BIM. These standardised rooms could be broken into components like clinical washbasin. In addition to square meter rooms, mounting equipment, fire rating and acoustic level, which could be taken from BIM and dropped on a plan, this could save time and helps in coordinating the project between construction stakeholders and facility managers. Designers confirmed the effectiveness of BIM use as they could put input of their previous projects and create a data set. In addition to clinical data, accident and recovery rate could be a great input in BIM as well as the adjacencies of departments and lifespan of a product such as doors, windows and flooring replacement.

Designers model the whole project in 3D, then use the model produced in order to create the schedule of areas, equipment, doors, ceiling and all technical and design details, which are then transferred into COBie drop, then coordinate it with all the models brought from the other disciplines such as M&E structure. In terms of BIM, use the CAD 'computer-aided

design' aspect of BIM and the COBie 'Construction Operations Building Information Exchange' aspect, 'Navisworks' in terms of BIM coordination between the MEP 'mechanical, electrical, plumbing', which is a 3D design review package integrated in BIM that is very helpful in coordinating the MEP in their projects. However, using BIM does not mean that they achieved the accuracy in the project. Designers also use Revit architecture in BIM and although they use Revit, they cannot use it in the beginning of the design process as it limits their creativity and their design, so they start using it at the second stage of the design, which is the technical phase. Designers use BIM libraries in their design, as some already have their own library within their practice such as HVAC 'Heating Ventilation Air Conditioning', 3D capabilities, in addition to carpentry, furniture (e.g. doors, windows, beds, sinks). They start using BIM and Revit models for the whole design. Despite BIM benefits within the construction industry that have been explained by the interviewees in the previous sections, one designer said that they use BIM, however this one does not inform the design, besides of the heaviness of the Revit tool they use for their design. Designers suggested that a designed room within BIM could be helpful to use as a template, although they use objects like external walls, but BIM helps more the M&E 'mechanical and electrical' engineers colleagues in visualizing the design and spotting where windows and ventilation could be placed as an example.

Some designers argued that BIM level 2 has not been reached yet as many companies claimed and the more you in-put the more you get from BIM because there are lots of information that a limited number of people are working towards it as it is a full model, yet not everyone shares. Interviewees said that the transfer of data regarding the project from users and FM is doable automatically while using BIM, although there is a need for training in order to extract it and import the information in a BIM format. Designers think that it is doable where you can add some characteristics while importing excel documents into Revit and use them as schedule recommendation. They need to convert the information received to BIM format. Although, some already have a database where they store all information in it. This could be great and time solving. Architects are sceptical about the transfer of data from FM and users and the usability for them, yet it could be done for a new built but not an existing built, as they do not have BIM compatibility with the project.

Designers approved that the transfer of data can be done, as they already captured data about equipment from users and stored it, however they used a different tool that interacts with Revit called 'Codebook', which helped in recording what changes have been made on the

project that users can have access to. The transferred of data would be helpful if it is an existing built. Still the problem is the compatibility to BIM format as clients have information about the project but do not use BIM and to convert the massive information given is not easy. BIM execution plan helps in running the estate and to be able to get data and information about the estate, users have to dictate to the design team about the process of functionality of it. It could be beneficial for everyone to spot the clashes and problems of the project on a tablet, which is accessed by the design team and the client could use. Further issues in terms of designing hospital wards could be related to the design such as space issues and the compliance to building notes and the derogations, besides of lack of spaces allocated to relatives, play rooms, day rooms and storage space, in addition to the connection to nature and views out from the room as well as the privacy**.** In addition, the protocol of evacuation and the accessibility as well as the way doors are managed could be an issue for circulation and the evacuation control. Designers, FM and clients should be involved at early stages of design, yet because they do not get involved, the briefing time gets short and mistakes could appear down the line. Finally, these designers clarified that the design should be done efficiently and to their best knowledge in order to provide a great and functional environment for staff and patients.

This chapter has discussed the analysis and findings of the semi-structured interviews, which answer the research question, and help in the development of the framework by supporting the evidence of the previous findings and the literature review. The following chapter will outline an in-depth discussion of the findings that help in answering the research questions and the development of the conceptual framework.

CHAPTER SIX

6 DISCUSSION AND DEVELOPMENT OF THE FRAMEWORK

6.0 INTRODUCTION

This chapter discusses the results and the findings presented in Chapters 5 and 6 in relation to the existing body of knowledge and the following research questions developed in Chapter 1:

1. What are the key design issues in hospital wards?
2. Are the designers of hospital wards producing suitable designs?
   2.1. Are designers aware of the key design issues and are they addressing them?
   2.2. What information is most useful to designers and is it available to them?
   2.3. What further information could produce better design and improve design decision making? And could it be transferred to them automatically?
3. Are the healthcare users satisfied with the design of hospital wards?

The research focused on the design of healthcare buildings and their suitability once in-use. Designers and healthcare users (including doctors, nurses and healthcare allied professionals) were surveyed and interviewed regarding the design issues in hospital wards, the design criteria, the type of data that would be useful to capture for designers and the users' opinions regarding the design. The study used a mixed method sequential exploratory design to achieve the research objectives, which involved a quantitative data collection using online surveys with 165 architectural practices to identify the design problems and issues, the architects and designers face in the design of healthcare projects. This phase was then followed-up by 14 semi-structured interviews to identify the type of data and information that should be captured and used as a reference for future projects to help improving design decision making. Finally, the last phase was to collect data from healthcare users using an online survey to compare their responses and their satisfaction with the architects' responses.

6.1 KEY DESIGN ISSUES IN HOSPITAL WARDS

The first question and objective of this study (see Chapter 1) was to identify the design issues of healthcare projects. To achieve this, the researcher investigated the design of hospitals and more precisely adults-inpatients ward, which involved a literature review, followed by an online survey. There were research works that explored the impact of healthcare environment on patients' well-being such as Devlin and Arneill (2003) who tackled three problems: patients' involvement with their healthcare (i.e. the role of patient control); the ambient environment (light, sound); and the emergence of specialized building types. Their theory about the healthcare design and its impact on the patient's healing was confirmed in the findings of the research as designers mentioned that patients need a healing environment through a better design. Designers also emphasised the existence of twelve issues starting from the spread of infections followed by daylight and artificial light, air quality, avoiding falls, noise, scalability, visual and acoustic privacy, light and shade, avoiding medication errors, furniture placement, isolation and finally colour used in the space. In addition to these issues, others were identified by designers that are fire strategy, space availability, adjacency of rooms and visibility to patient' rooms.

Joseph and Rashid (2007) discovered that design issues such as air quality, lighting, and room design impact the health and well-being of patients in terms of nosocomial infections, patient falls and medical errors. Although Joseph and Rashid (2007) mentioned that the design of hospitals can improve the aforementioned issues that help in healing the patients; designers highlighted in this research that these ones are mainly a management issue rather than a design one. Regarding the issue of avoiding falls, designers said this could depend on the move of furniture by the staff around the room, however the design could be adapted to new re-arrangement of furniture for better patient' safety. Designers pointed out that the visual and acoustic privacy could be achieved through the design of single bedrooms that offer privacy, dignity and confidentiality for patients besides of preventing the spread of infection control. This was found in (Alfonsi et al. 2014) who cited in their research "the most significant reduction of nosocomial infection is due to the introduction of single rooms instead of multiple bedrooms". Yet, designers noted that the design of single bedrooms affects adversely the psychological side of patients. Indeed, healthcare users confirmed that children would benefit from the single bedrooms more than adults do, as adults need to interact and socialise with other patients.

Additionally, open ward would help in monitoring all patients at the same time rather than travelling from one room to another. In addition to the quick recovery rate of patients that doctors and nurses have witnessed when they are in an open ward. The design of single bedrooms has seen a great controversy in research as it has been clearly seen that it reduces the infection rate, the noise and medication errors, as well as increasing the privacy aspect (Ugboma et al. 2011). However, from the findings designers noted that the design of wards requires a mixed use of single bedrooms and multi bedrooms. Van de Glind et al. (2007) discussed the benefits of single patient rooms for patients by investigating an extensive literature review and using six outcome measures that are privacy and dignity of patients, noise and quality of sleep, patient satisfaction with care, hospital infection rates of MRSA, patient safety: fall accidents, medication errors and patient recovery rates, complications and length of stay. However, they have not been able to answer this question yet as the evidence to prove the benefits of single rooms is not sufficient. On the other hand, the healthcare users noted that the use of single bedrooms would be more beneficial for very ill patients in order to limit the infection and facilitates the one-on-one care. Yet, other research works have raised the issue of privacy in hospital multi bedrooms by emphasising that the design of multi bedrooms affects this aspect but it can still be positive in terms of choosing lower integration and control values (Alalouch and Aspinall 2007).

From the findings, designers highlighted five main themes that help in identifying the issues; these include the room layout, the technical requirements needed, the design guidelines used, user requirements, feedback, knowledge, and experience they refer to in the design. Douglas and Douglas (2005) discussed the design indicators for healthcare built environment improvement, as they divided them in external and internal indicators. These include wayfinding, internal signage, lighting, ambience and control noise levels and acoustics, temperature control and ventilation. In addition to access to and from transitional spaces, entrances, reception, social spaces, ward environment, views and natural outlook, washrooms/hygiene facilities, personal space and ownership, privacy and dignity, nurses station/staff contact, safety and security, homely facilities, accommodation for relatives, catering facilities, leisure and recreational facilities, shops and personal services and telephone, television and Internet. Besides the external indicators that are accessibility and transport, integrated public transport, parking facilities for staff and parking facilities for patients/visitors.

Others include on-site traffic and pedestrian movements, wayfinding for directional aids based on named roads and buildings, landscaping and green areas with access from internal areas, noise reduction services, safety and security in and around hospital grounds. These indicators were extracted in the findings as designers pointed out that it is important and necessary to focus on the accessibility of the rooms, the location and their relationship to the wards, circulation around the patient and furniture placement and final finishes. In addition to the adaptability and flexibility of the rooms, the optimal adjacencies to other departments, the circulation in spaces and the room area and size. They have mentioned that there is a lack of showers in rooms. They also mentioned that they would like to avoid the layout repetition during the space planning by focusing on the interior design and finishes, bedroom model, good outlook of rooms, central bed location. In the findings, designers classified the daylight and artificial lighting, the air quality and temperature, observation, sightline to bed, noise, infection control and privacy and dignity as technical requirements. In addition to the patient visibility, the type of materials that would prevent the patient falls, nursing workflow and travel distances.

Furthermore, designers identified the accessibility to views and building services installation, visual and acoustic privacy, the number and type of outlets, M&E requirements such as mechanical ventilation, air filtration, humidity control, HVAC, spatial arrangements, coordination of the building design, isolation facilities, clinical functionality, and buildability. Choi et al. (2012) identified the factors that could impact the patient's well-being in the room as they investigated the relationship between the lighting and the length of stay, in addition to the visual discomfort that daylight may cause to patients, the shading and the recovery process due to the benefits of providing daylight in the room.

6.2 INVESTIGATION OF HOSPITAL WARDS DESIGN SUITABILITY

This section discusses the comparison of the findings between the designer and healthcare user surveys, where two areas were distinguished that are areas of alignment and non-alignment. This was illustrated in the table below (the common issues are in order of the appearance in the surveys).

Common[1] issues	Recognition		Implementation	
	Evidence derived from Designers' surveys and Healthcare Surveys		Evidence derived from Designers' surveys (open-ended questions) + interviews and Healthcare Surveys (open-ended questions).	
	Designers	HC users	Designers	HC users
Infection control	48.3%	Not ranked	Designers' survey Table 4.2 & interviews & open-ended quest	Healthcare survey analysis (some quotes)
Medication errors	31%	Not ranked	Designers' survey Table 4.3	No data available
Falls	27.6%	Not ranked	Designers' survey Table 4.4	No data available
Scalability, flexibility and adaptability of the space	31%	Not ranked	Designers' survey Table 4.5	No data available
Visual and acoustic privacy	24.1%	Not ranked	Designers' survey Table 4.6	No data available
Isolation of rooms and beds	20.7%	Not ranked	Designers' survey Table 4.7	Same as single rooms
Light and shade (balance)	27.6%	Not ranked	Designers' survey Table 4.8	Combo of shade and lighting
Colour used in the space	24.1%	Not ranked	Designers' survey Table 4.9	No data available
Daylight and artificial light (balance)	37.9%	40.4%, 34% good	Designers' survey Table 4.10	Healthcare survey Table 4.36 and 4.38
Air quality	37.9%	Not ranked	Designers' survey Table 4.11 open-ended quest and interviews	No data available
Noise (e.g. by effective sound insulation of the space)	37.9%	48.9% disagree	Designers' survey Table 4.12 open-ended quest and interviews	Healthcare survey Table 4.44
Furniture placement	20.7%	46.8% agree	Designers' survey Table 4.13 open-ended quest	Healthcare survey Table 4.48
Single rooms	Not ranked	61.7%	open-ended quest and interviews	Healthcare survey Table 4.35
Open ward	Not ranked	38.3%	open-ended quest and interviews	Healthcare survey Table 4.35
Daylight	37.9%	40.4% good	Designers' survey Table 4.10 & open-ended quest & interviews	Healthcare survey Table 4.36
Shading	27.6%	36.2% v.good	Designers' survey Table 4.8 & open-ended quest & interviews	Healthcare survey Table 4.37
Artificial lights	37.9%	34% v.good	Designers' survey Table 4.10 & open-ended quest & interviews	Healthcare survey Table 4.38
Importance of the design of patient areas	Not ranked	59.6% agree	open-ended quest & interviews	Healthcare survey Table 4.39
Recovery in open ward in better than single rooms	Not ranked	34% agree	Designers' survey & interviews	Healthcare survey Table 4.40
Privacy	24.1%	31.9% disagree	Designers' survey & interviews	Healthcare survey Table 4.41
Size of doors	Not ranked	51.1% agree	open-ended quest & interviews	Healthcare survey Table 4.42
Windows are large enough	Not ranked	34% agree	open-ended & interviews	Healthcare survey Table 4.43
Sound insulation	37.9%	48.9% disagree	Designers' survey Table 5.12	Healthcare survey Table 4.44
	Not ranked	42.6% agree	open-ended quest and	Healthcare survey

[1] i.e. identified by both groups of respondents

Temperature			interviews	Table 4.45
Size of patient areas	Not ranked	51.1% agree	open-ended quest & interviews	Healthcare survey Table 4.46
Clinical furniture quality	Not ranked	59.6% agree	open-ended quest & interviews	Healthcare survey Table 4.47
Placement of clinical furniture	20.7%	46.8% agree	Designers' survey Table 5.13 open-ended quest & interviews	Healthcare survey Table 4.48
Washing facilities	Not ranked	44.7% agree	open-ended quest & interviews	Healthcare survey Table 4.49
Electric points	Not ranked	57.4% agree	open-ended quest & interviews	Healthcare survey Table 4.50
Window blinds	Not ranked	42.6% agree	open-ended quest & interviews	Healthcare survey Table 4.51
Equipment storage	Not ranked	48.9% agree	open-ended quest & interviews	Healthcare survey Table 4.52
Sightline	Not ranked	40.4% disagree	open-ended quest	Healthcare survey Table 4.53
Visibility helps with recovery	Not ranked	53.2% agree	open-ended quest & interviews	Healthcare survey Table 4.54
Privacy and dignity of patients are maintained	Not ranked	51.1% agree	open-ended quest & interviews	Healthcare survey Table 4.55
Size of showers is sufficient	Not ranked	48.9% agree	open-ended quest & interviews	Healthcare survey Table 4.56
Bathroom size is big	Not ranked	46.8% agree	open-ended quest & interviews	Healthcare survey Table 4.57
Size of patient rooms	Not ranked	55.3% agree	open-ended quest & interviews	Healthcare survey Table 4.56
Visitors have enough space in the rooms	Not ranked	51.1% agree	open-ended quest & interviews	Healthcare survey Table 4.59
Communal space is well equipped	Not ranked	36.2% agree	open-ended quest & interviews	Healthcare survey Table 4.60
Circulation areas are conducive	Not ranked	31.9% agree	open-ended quest & interviews	Healthcare survey Table 4.61

Table 6.1: Comparison of the findings.

A. Areas of alignment between designers and healthcare findings

Healthcare users' opinions were mostly positive (agree/strongly agree) in terms of the design of patient areas that is important to the patients' recovery. In addition to other design indicators such as size of doors, windows, showers, patient areas, the washing facilities, bathrooms and patients' bedrooms size. The additional indicators of the design that are related to the air temperature, the electric points, the window blinds, equipment of storage, the space in the rooms and the circulation area were agreed on from users. Healthcare users agreed on the placement of the clinical furniture that is well suited to the recovery of patients, as well as the quality that affects their wellbeing; this has been raised as an issue for Designers who discussed the placement of furniture and their quality could be bad as they said it is outside of their control.

Healthcare users said that there are few staff rooms, which are poorly equipped, as well as a lack of changing rooms, showers and restrooms for nurses and doctors. These ones were confirmed in the designers' interviews as stated in the transcripts "well, it is the space issues

and the insane BN and derogation issues, the space allocation about relative rooms, day rooms, play rooms, storage (massive problem) because always it's reduced". (Designer 1)

Healthcare users noted that there are important spaces to include in the ward that are outdoor spaces, rehabilitation and therapy areas, play areas, day rooms, quiet rooms for patients and their visitors, in addition to the kitchens, gardens and offices for staff. These findings led the researcher to conduct semi-structured interviews with Designers in order to confirm and validate the findings of the surveys.

1. **Single bedrooms and open wards**

Both designers and healthcare users agree on the importance of the design of single bedrooms that is important for the recovery and healing process of the patients as it has positive aspects by offering privacy and confidentiality for patients as well as minimising noise, distraction and the spread of infection. However, both samples said that the single patient rooms could be of benefit for children mainly and for very ill patients. While, open ward could be better for adults in terms of patients' safety, social interactions, psychology and prevention of loneliness and isolation, in addition, to facilitate the observation and monitoring of patients by staff. These statements were confirmed in the interviews' findings as shown in the extracts below.

> "You know more and more wards are becoming single patient rooms apart from children. I think the older patients ward should be in a multi bed bays because they need to talk to each other and their family members might not come". (Designer 1)
>
> "…I think rooms should be single because of the recovery time, cleaning process as you can never clean the ward because its' always occupied, infection control as well. I'm against the ward and multi bed bays because of the different states of the patients and cleaning and comfort". (Designer 3)
>
> "There is an interesting debate that is ongoing that concerns the design of wards. We moved from multi bed bays to single bedrooms. What we get from POE, the clinical staff have to supervise the wards, they want to move from 100% single bedrooms to multi bed bays, and it's probably going to change in the 5 to 10 years. There is a lot suggesting the isolation in the single bedrooms, which is not good for the psychological side". (Designer 10)

2. Lighting

In terms of lighting, there are two aspects: daylight and artificial light. The designers were very conscious about the management of glare and solar gain; the healthcare users agreed and they were content about it. Yet, they said that there were still some spaces such as offices and bathrooms that do not benefit of the daylights. In addition to the orientation of the building that permits the rooms to have good daylight, as well as the distance to buildings that could eventually minimise the daylights in the ground floor. Regarding the artificial lights, Healthcare users said that they were satisfied with the level of lighting they observe, that the glare could cause headache and discomfort to patients, hence it needs dimmer switches to soften the light on bedside tables.

According to Healthcare users, shading is very good as it could be done either by drawing the curtains or having tinted windows. This was reported by designers in the interviews "From the HC perspective, the key is to assist clinical teams help people to get better, the efficiency that the service provides, natural light" (Designer 8) and "It's important for the privacy and dignity of the patient, control environment. Bed-head choice, comfort, put patients and visitors at ease. Adjust the light" (Designer 5). This was illustrated in Table 6.1 and detailed with commentaries in the table below.

Common issues	Recognition		Implementation	
	Evidence derived from Designers' surveys and Healthcare Surveys		Evidence derived from Designers' surveys (open-ended questions) + interviews and Healthcare Surveys (open-ended questions).	
	Designers	HC users	Designers	HC users
Daylight	37.9%	40.4% good	Designers' survey Table 5.10 & open-ended quest & interviews	Healthcare survey table 5.10
Comments	Lighting is good **but** some offices and spaces do not benefit from natural lights because of the proximity to other buildings and their orientation, and the patient's dignity.			
Shading	27.6%	36.2% good	Designers' survey Table 5.8 & open-ended quest & interviews	Healthcare survey table 5.36
Comments	Healthcare users said the shading is good in the room **but** this could depend on the curtains and blinds and the ability of patients to draw them.			
Artificial lights	37.9%	34% good	Designers' survey Table 5.10 & open-ended quest & interviews	Healthcare survey table 5.37
Comments	Healthcare users were satisfied **but** argued that the bright lights could affect the vision and put more stress on patients, causing headache, nausea and tiredness. They also suggested that having dimmer switches on the bedside tables could be beneficial. Yet, one said it is dark in the room and that leads to depression and the other said the low energy is bad for visually impaired patients.			

Table 6.2: Areas of alignment.

B. Possible areas of non-alignment between designers and healthcare findings

Although designers and healthcare users agreed on certain issues being important, yet when it comes to implementation there is a marked difference of opinions as to where these issues are properly attended.

1. Privacy

The healthcare users were not satisfied about 'privacy', yet they agreed that the patients' dignity and privacy are maintained and this contradicts designers' thoughts that this is achievable but difficult as shown in the extracts below.

> "We think of the head bed orientation to keep privacy" (Designer 2)
>
> "Privacy is the major one, you can quite easily get floor on a ward. How you manage the privacy aspect, it's critical and you need to do a balance between both sides" (Designer 9)
>
> "Privacy and dignity is high on the agenda, you can centralize stations to reduce footfalls, IT equipment and technology has its place, so you can monitor the patient without being on top of them" (Designer 11)

This was illustrated in Table 6.1 and detailed with commentaries in the table below.

Common issues	Recognition		Implementation	
	Evidence derived from Designers' surveys and Healthcare Surveys		Evidence derived from Designers' surveys (open-ended questions) + interviews and Healthcare Surveys (open-ended questions).	
	Designers	HC users	Designers	HC users
Privacy	24.1%	31.9% Disagree	Designers' survey & open-ended quest and interviews	Healthcare survey table 5.40
Comments	Healthcare users agreed on the privacy and dignity of patients being maintained, but disagreed that the patients have enough privacy in patient areas. Yet, designers in the open-ended questions section and the interviews argued that they are trying to do their best to keep the privacy of patients despite the difficulty to achieve it, while balancing the observation and monitoring of patients at the same time.			

Table 6.3: Disagreement aspect 1.

2. Sound insulation (noise)

The other disagreement is about the sufficiency of sound insulation and acoustic privacy. One designer said that they deal comfortably with the issue of "Visual and acoustic privacy" (Designer 6), whereas healthcare users disagreed. This was illustrated in Table 6.1 and detailed with commentaries in the table below.

Common issues	Recognition		Implementation	
	Evidence derived from Designers' surveys and Healthcare Surveys		Evidence derived from Designers' surveys (open-ended questions) + interviews and Healthcare Surveys (open-ended questions).	
	Designers	HC users	Designers	HC users
Noise (e.g. by effective sound insulation of the space)	37.9%	48.9% disagree	Designers' survey Table 5.12	Healthcare survey table 5.43
Comments	Although designers said that they focus on the sound insulation in the design, HC users disagreed that it was sufficient.			

Table 6.4: Disagreement aspect 2.

3. Sightline

Healthcare users agreed that the visibility from the corridors to patients' rooms helps with their recovery; however, they disagreed on the adequacy of the sightline from the doctors and nurses' stations to the patients. Designers however claimed to use the sightline as an important criterion for the design of wards. Designers reported that they get feedback on the sightline and they admitted that it is difficult but achievable as Designer 13 stated "…visibility for staff to be able to monitor the patient". This was illustrated in Table 6.1 and detailed with commentaries in the table below.

Common issues	Recognition		Implementation	
	Evidence derived from Designers' surveys and Healthcare Surveys		Evidence derived from Designers' surveys (open-ended questions) + interviews and Healthcare Surveys (open-ended questions).	
	Designers	HC users	Designers	HC users
Sightline	Not ranked	40.4% disagree	open-ended quest	Healthcare survey table 5.52
Comments	Although, designers and healthcare users agreed on the raised issues, HC users felt this was not implemented in practice, and evidence for this is shown above.			

Table 6.5: Disagreement aspect 3.

From the tables above, it is clear that designers try to address all issues to the respect of their orders. However, due to the aforementioned issues' priorities, designers fail at tackling other important issues i.e. sightline, sound insulation and privacy. This demonstrates that designers do not produce designs that accord with users' perceptions of what is required; however, they

try to cover all issues mentioned by them or in the feedback given to them by healthcare users. The next section covers the issues of design in hospital wards cited by designers.

6.2.1 AWARENESS OF DESIGNERS OF THE KEY DESIGN ISSUES AND THEIR RESPONSES

To address this question, the researcher interviewed architects specialised in the healthcare sector in order to investigate the data and information they need from users that could be captured and eventually used as a reference to improve design decision making. The findings indicate that the data designers need from HC users include the schedule of accommodation, a recovery rate of patients, a list of equipment, user engagement and integration, consistent feedback and briefing throughout the project. Designers emphasised the importance of healthcare users' feedback and its impact on the design. Nevertheless, the feedback from healthcare users is difficult to get, while the FM feedback is harder because of the lack of involvement at the early stages of the project. Yet, the design would be incomplete without the facility managers. Furthermore, patient feedback can be lost either because of the long process that designers go through or because of the management issue. On the other hand, facility managers should provide designers with a brief on area schedule, adjacency matrix, material choice and its lifespan, fire and management policies. Designers also need to know about the transports, patients' body, staffing and finances, project procurement and ground conditions prior to the design of the ward.

The findings indicate that designers need an update of the design guidelines that they use as it has not been updated for a while, and among them health building notes 'HBNs' and health technical memoranda 'HTMs'. Hignett and Lu (2009) Reported that the design relies on the use of guidance such as HBNs, however, it could be a constraint limiting the design and impacting the tendering process through non-compliance. Moreover, designers need some requirements and feedback while designing the ward or after the building is in use and these should be given by the users such as continual user engagement, cost issues, space required, brief establishment, design follow up, user choice in design.

Furthermore, designers argued that users' opinions are sometimes entrenched and conflicted and that makes it difficult to meet the client expectation, however, agreement of all stakeholders and a strong leadership is needed to achieve good design. In addition to the review and approval process from users of the design, clinical ratios, number of single beds, type of rooms, client requirements, patient and staff demography, ease of maintenance,

briefing, POE, patient and staff feedback, peer reviews and user consultation. Designers mentioned that the data that would help in enhancing the design of a hospital ward could be recovery rate of patients in a facility, user interaction, feedback and consistent briefing.

6.2.2 THE UTILITY AND AVAILABILITY OF INFORMATION IN THE DESIGN OF HOSPITAL WARDS

Designers highlighted that users' and patients' feedback is important in the design; however, they do not receive it. In addition to FM feedback that is also important but not provided to designers, hence data is lost and not exploited. This data could be unexploited because of a number of reasons as explained previously by designers, either i.e. financial, political or timing. These factors could affect adversely the end-product as demonstrated by Love and Li (2000) who concluded that the incomplete and missing information leads to rework and design changes. They also set a list of quality management practices that could help in improving the performance of construction projects "requirements of clients and end users. (a) the requirements of the client and end-users; (b) producing correct and complete drawings and specification; (c) coordinating and checking design documentation (including inter-organizational coordination; (d) conducting design verification through design analysis reviews; (e) controlling changes (e.g. scope freezing); and (f) committing to providing a quality service" (Love and Li 2000). Designers argued that the design would be better if they could exploit all usable feedback (including some of that which at the present is unexploited). They also explained that the value of exploited data depends on its availability and it would help in improving the design. In other words, designers could receive and capture the available data, however, the lack of this data could affect the progress and the design decision making. Yet, designers emphasised the importance of unexploited data as their value exceeds the value of exploited data. In addition, the data received on time would help more in enhancing the design decision making and avoid repeating the same mistakes. Furthermore, designers can compensate the gaps of information through experience, knowledge, learning and briefing from users.

The other reason data could be unexploited is its decentralization within the system as Martin et al. (2014) claimed that decentralized organisations have less communication than those centralized resulting in bad performance. Robson et al. (2014) stated that Building Information Modelling (BIM) could help in centralizing the design information and enhance the communication amongst the stakeholders. Also, Kamara et al. (2002) indicated that it is

required to integrate computer interface within the framework that captures the client requirements, using information technology (IT). The findings of this study indicate that it is primordial to get access to information, document it explicitly, share it and incorporate it into a knowledge bank (repository).

6.2.3 FURTHER INFORMATION FOR BETTER DESIGN AND DECISION MAKING

Carpman and Grant (2016) mentioned that the physical environment of the healthcare premises is important (for patients, doctors, nurses, and visitors); hence there must be a balance between the technological side and human needs and their comfort. They also noted that a good design helps in reducing stress and anxiety and is a major factor in the healing process. From the findings, some designers noted that BIM has been a beneficial platform that is used on a daily basis in order to fulfil the choice of client requirements. Designers claimed that the transfer of data from users to designers could be possible through BIM, yet training to import and export information in a BIM format is necessary. Problems could exist in the compatibility of files with BIM, as all info/data need to be compatible with BIM format. Chan (2014) identified some barriers of implementing BIM in the construction industry such as lack of training, lack of client demands, lack of standards and interoperability/ compatibility issue. This was identified in the findings as well, that some users/clients may not use BIM format and this affects the transfer and communication of data between designers and users. Furthermore, the designers were confident about the way data could be transferred to them automatically through BIM by using Construction Operations Building Information Exchange (COBie) codes as mentioned by the participants in Chapter 6. However, this could require training, software compatibility and more importantly, was only possible with newly-built facilities, as existing buildings are unlikely to be in BIM format and it is difficult and expensive to retrofit BIM to an existing building.

6.3 INVESTIGATION OF THE HEALTHCARE USERS' SATISFACTION WITH THE DESIGN

McLaughlin (1975) mentioned that the hospital is one of the building types that changes the most where the modification impacts its physical life. In other words, the design of hospitals changes constantly throughout the years and this is why designers need to pay attention to the outcomes of patients and their opinion about it as they are the ones who live in the building.

As seen in the previous section (comparison of the findings), healthcare users showed their satisfaction on many statements, for instance the washing facilities, the window and door sizes and others. . Yet, they showed a dissatisfaction about sightlines, privacy and sound insulation. Despite designers noting that, when having access to them, they sometimes get positive feedback from patients' groups and users. However, users still complain about the lack of spaces allocated to relatives, playrooms, day rooms and storage space, in addition to the connection to nature and views. Users added the aspects that are not satisfied about, which include a lack of offices, restrooms and showers for staff, besides spaces for rehabilitation/physio and recovery rooms. In contrast with Mourshed and Zhao (2012), who studied the perception of healthcare users in terms of their physical environment, and concluded that maintenance aspects were perceived to be more important than spatial design, this study has found that users did not complain about the maintenance as much as about the design itself.

In another study, Mahmood et al. (2011) established similar factors that are associated to the physical environment, which could have an impact on nursing station areas "lack of storage space for supplies, poorly designed nursing station layout, inadequate space in charting/documentation area, lengthy walking distances to patient rooms, insufficient patient surveillance opportunity/lack of visibility to all parts of the nursing unit.." They also added small "size of the medication room, high noise levels in patient care unit and poor lighting, and privacy in the nursing stations. Many of these issues (e.g., noise, layout, walking distance, patient surveillance opportunity) were also identified as important environmental elements in the literature. In addition, it is worth noting that a few of these environmental issues, for example, walking distance from nurses station to patient rooms, patient surveillance opportunity/lack of visibility, have been associated with staff effectiveness in the event of patient falls (Feldman and Chaudhury 2008, Gulwadi and Calkins 2008)".

6.4 FORMULATED FRAMEWORK

The conceptual framework (Figure 6.1) has been developed based upon the analysis of data collected from HC users and designers and according to literature review. The framework is unique to other existent frameworks because of the type and the way data has been collected. This includes the designing and development of a wide ranging innovative key features, which have been associated with "Design Guidance" and "Design Matters". The former

includes Specifications, Codes and practice notes, experiential feedback. The latter comprises clinical good practice, staff comfort and safety, patient comfort and safety, and cost. Additional features of the framework were extracted from the literature review such as "General Design Problems". Furthermore, the suggestions offered by the experts during the validation process of the framework were also included. The framework was developed based upon the findings of the surveys and interviews. The conceptual framework is called 'EBD of healthcare facility' and, it consists of two parts; design matters and design guidance. It includes designers and clients (i.e. healthcare users, FM, director of hospital or government). At the beginning of the process, designers meet with the clients during the brief to set their own needs. These include project procurement, schedule of accommodation, recovery rate of patients from previous healthcare settings, area schedule and adjacency matrix. During the brief meeting, clients also discuss their requirements that could be privacy, sound insulation, sightline, room layout and others (see Figure 6.1). These two steps are: brief and client requirements are called specifications, which is then followed by the use of designers for the codes and practice notes (i.e. health building notes 'HBNs', health technical memoranda 'HTMs', activity database 'ADB' standard) and others. When designers do not get the requirements and feedback they need from the specification step or the design regulations, they compensate it with their experiential feedback that could involve personal experience, POE, lessons learnt and tacit knowledge. Some of these lessons learnt could be encapsulated within the knowledge repository of their system. The design guidance is then followed by the design matters that consists of the design issues designers need to pay attention to and address properly. These include clinical good practice, patient and staff safety and cost. The design guidance and matters would help in achieving the healthcare facility project, which improves the design decision making and the lessons learnt. At the end of the design phase, designers need to check the general design problems such as (infection control, daylight, artificial light…etc.). The lessons learnt from the project will then be fed back to the knowledge repository that feeds back the designers before the brief of the next project.

The conceptual framework was developed at a relatively high level and some of the clients' requirements and designers needs cited in the conceptual framework helped in developing the matrices of pre-design requirements and post-design evaluation illustrated in the following section.

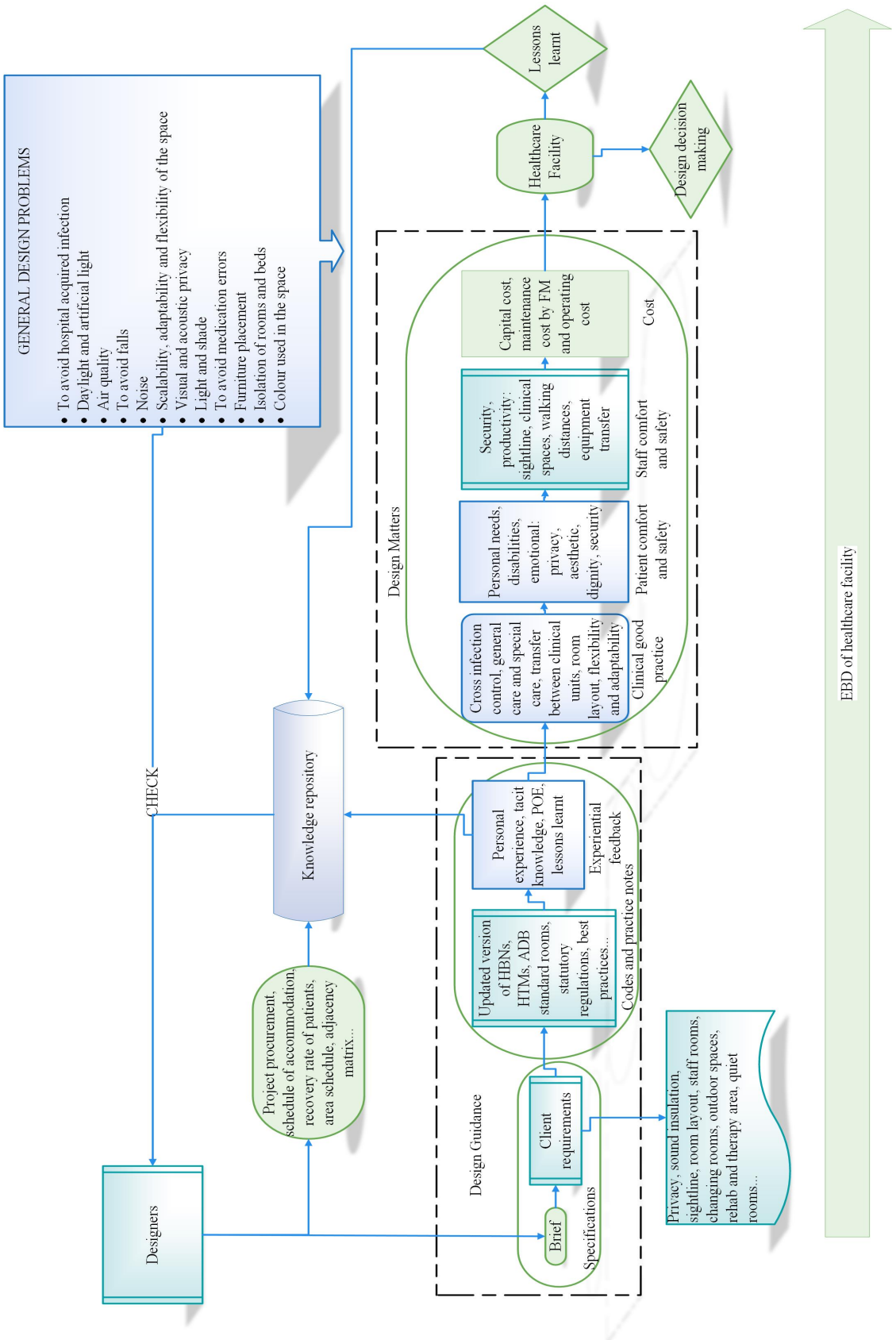


Figure 6.1: Conceptual Framework of evidence-based design of healthcare facilities.

6.4.1 THE VALIDITY OF THE CONCEPTUAL FRAMEWORK

The last phase of the research covers the validation of the conceptual framework. The triangulation method with the surveys and interviews have been used as an internal indicator to validate the findings of the data. Whereas the panel of experts is going to be used as an external factor to validate the framework. The opinions of expert healthcare facility managers were used to evaluate and assess the validity of the conceptual framework. The discussion with content experts would help in validating the content of the findings through their familiarity with the field of the content (Thorn and Deitz 1989). A panel of two expert HCFs managers who have knowledge of the design of HCFs and have a close experience of working with the HC users and designers have been identified for this research to discuss the process of conceptual framework implementation and its validity.

The first expert is a Healthcare and Higher Education Project Manager with 30 years' experience. He has managed all stages of the project lifecycle in a wide range of hospitals and primary care settings. He worked for NHS Trusts, in the private sector and latterly in the university sector. He has also been an Independent Certifier and Technical Adviser on major Healthcare PFIs. In these roles, he has gained in-depth experience of getting results, working with clinicians and the construction industry.

The second expert is a Chartered Engineer, has 45 years Healthcare Economy experience, in of variety role such as Maintenance manager, Capital project Manager and Estates Manager, formerly with NHS trusts and including eight years with the Department of Health NHS estates.
Latterly, following retirement from the NHS 5 years ago, he has continued as an independent consultant providing services to NHS trusts and training organisations. His portfolio focuses on Strategic Estates management, Compliance and Governance of the Estates, where the major role being that of Electrical Authorising Engineer. He has also previously, and continues to be, engaged with his professional institutions to support the need for support to the organisations and members. This involved Regional chair and national Vice president of CIBSE similarly Branch Chair and Secretary of IHEEM.

A meeting of 1 hour was set-up with these experts for the validation of the conceptual framework and the matrices. The meeting was recorded with the consent of the experts, and notes were taken by the researcher. The phases of the conceptual framework were first

explained then feedback was noted. Both experts were satisfied with the conceptual framework; nonetheless, they added some valuable feedback and refinements to the framework and matrices. In terms of the conceptual framework, the feedback mainly concerned the part of the framework that related to Design Guidance Documents and General Design Problems.

In the original framework, under the heading 'Design Guidance' several sources of information were identified. Expert 1 suggested the addition of a further source:

> "Capital Investment Manual (CIM) is a 12 year old document and very useful document for executing capital project in the NHS".

Expert 2, explained the origin of this document further:

> "When the NHS became more of a free market, it became decentralised and the NHS estate produced this document to allow more less traditional form of contracting like PFI, design and build, manage and contract and the CIM gives more guidance to do this." (Expert 2)

Expert 2 continued, by saying:

> "In one contract there are input and output specifications, but the output specifications is just a generic and statement of what they need is either value engineering or cost engineering so it becomes more fluid, so the discussion is exactly who is the client".

He also added:

> "Value for money VFM and benchmarking is also important to include in the beginning"
>
> "The project cannot pass without this and the committee won't accept it before benchmarking".

Expert 1 emphasised the importance of involving patients as he said:

> "When the designer meeting clients, the client could be someone like us but in fact behind us, clinicians and patients as well who may be not singing the same song".
>
> "You really have to involve the patients as equal partners".
>
> "Fully Involving patients in the design to some depth"

He stated that there is a process where patients could be involved in the design:

> "There is a Co-design where they involve patients fully in the design" (Expert 1)

Expert 2 agreed on this statement by saying:

> "The customer is the patient so it is crucial to involve them in the design" (Expert 2)

In the ‘codes and practice notes’, and ‘experiential feedback’ Expert 1 said that there are other design regulations that designers could use:

> “Repeatable rooms is also interesting to add in the codes and practice notes, also BSRI for example and other non NHS sources”. (Expert 1)

and he continued by saying:

> “Design quality indicator DQI need to be done in the development of the project in the codes and notes part.” (Expert 1)

In terms of lessons learnt, Expert 2 said that it is a key issue because of the fragmentation in the industry by saying:

> “Feedback the lessons learnt was never a big strong point for me that’s a key issue, in the industry we are all fragmented, so if they don’t join up they don’t have that feedback.”

He also added:

> “Ideally there should be a discussion of how the project should be handed over.” (Expert 2)

According to Expert 1, there is a solution of solving FM problems, which is the use of BIM:

> “One way of doing that, it is not a design issue but may affect he design is the use of BIM, I think using BIM solves the FM problems, you should be able to deliver a maintenance BIM for the project cause you have all the assets in there.”

He also explained:

> “It is not a tool but a full package that helps in delivering the project, a drawer full of drawings; it helps in identifying the list of equipment and others”. (Expert 1)

Expert 2 said that this could be a ‘wish list’:

> “Ideally and a wish list is to have a fully developed BIM.”

Both experts concluded:

> “I think the black dotted line ‘Design Matters’ is a really strong part of your model, I think for me that comes out the best” Expert 1
>
> “I agree” Expert 2

The conceptual framework has been refined after the validation phase by taking into consideration all the feedback developed during the meeting (see Figure 6.2).

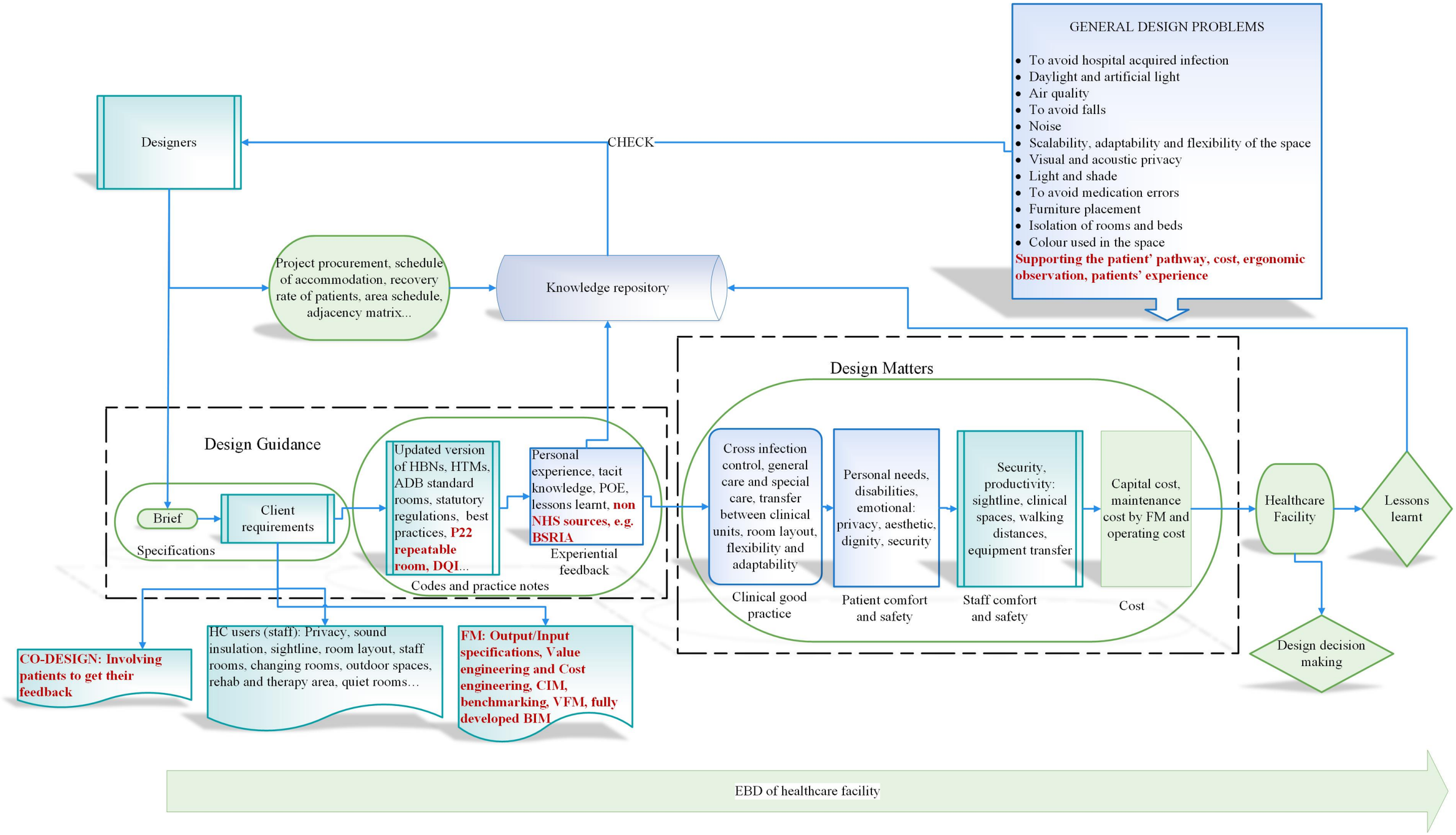
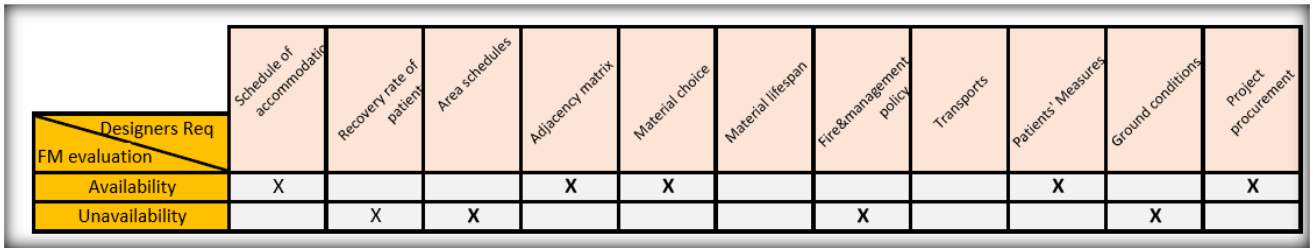


Figure 6.2: Conceptual Framework of evidence-based design of healthcare facilities (after validation).

6.5 DEVELOPED MATRICES

The findings of the research helped in developing two matrices related to the design of healthcare facilities. The first matrix is called "Pre-design Requirements", which consists of designers' requirements that have been identified in the interviews (Chapter 5). These requirements were the missing data/information that designers would like to receive from the facility managers and clients. The second column is assigned to the facility managers and clients who will notify designers with the availability or unavailability of the requirements needed as illustrated in the figure below.



Designers Req / FM evaluation	Schedule of accommodatio	Recovery rate of patient	Area schedules	Adjacency matrix	Material choice	Material lifespan	Fire&management policy	Transports	Patients' Measures	Ground conditions	Project procurement
Availability	X			X	X				X		X
Unavailability		X	X				X			X	

Figure 6.3: Matrix of Pre-Design Requirements (before validation).

The second matrix is called "Post-design Evaluation", which consists of Healthcare users' requirements that have been identified in (the surveys -Chapter 4- and interviews -Chapter 5-) These requirements were the needs of HC users and the spaces they lack in the ward. The second column is assigned to designers who will evaluate the tasks 'requirements' as achieved, unfinished or failed as illustrated in the figure below.

HC users Req / Designers' evaluation	Privacy	Sound insulation	Sightline	Room layout same handed	Room layout inboard	Staff rooms	Changing rooms	Outdoor spaces	Rehab & therapy area	Quiet rooms
Achieved	X			X	X		X			X
Unfinished		X	X					X		
Failed		X	X					X		

Figure 6.4: Matrix of Post-Design Evaluation (before validation).

6.5.1 THE VALIDITY OF THE MATRICES

Regarding the Pre-Design Requirements matrix, Expert 2 added some requirements that should be included in the design as follows:

> "The key issue that is not here, which is not only political but a design issue 'climate emergency' that could demand more money to spend on it, climate is getting warmer or colder in some areas"
>
> "Sustainability is similar and needs to be part of this"

In addition to other factors that are:

> "Resilience/business continuity, Energy, Waste is again key issue for my point of view, still working in hospital and we still get the same problem, Transport policy, location/access as some hospitals are built out of town, Demographics is also important to know how many people you are designing for". (Expert 2)
>
> "Value management starts at the beginning and all the way throughout the project then comes Value engineering". (Expert 2)

Expert 1 added:

"That's important because when the designer asks the client: is what is the budget? the cost is important"

"You could also add infection control and prevention that has to be at the start is fundamental"

Expert 2 continued talking about the requirements that should be taken into consideration:

> "Again any compliance with the model, NHS compliances is fundamental because you need it officially for the government you need to show them as requirement at the end of the project"
>
> "Flexibility of design"
>
> "Future proofing to allow for flexibility of use and finally types of contracting ie D&B , PFI , Construction management, management contracting, guarantee maximum price (GMP) , traditional and partnering (P22)"

Both experts added comments for the Post-Design Evaluation, as Expert 2 talked about the way wards are designed

> "The rooms and the clinical station sometimes are like an island one centred in the middle and rooms all around"

In terms of privacy and observation aspects, Expert 1 said that these issues are contradictory in achieving:

> "Sightline, privacy and observation is contradictory to achieve"

However, he gave an example of a successful design of a HCF that maintained privacy and observation:

> "There is an example of Royal Papworth Hospital is like an egg shape, rooms have like a 100% single bedrooms they are not called wards they are like floor 1 room 1 to 40 every room has glaze partition patients have privacy and clinicians have observation and sightline, it's a prestigious hospital". (Expert 1)

Expert 1 added that achieving those issues would be easier if you had a detailed business checklist:

> "For this sort of thing you need to have detailed checklist that could be covered in the business case but you must have a 1:100 plan".

Ergonomics, patient pathway and patient flow were added by both experts in the 'General Design Problems' and the Post-Design Evaluation:

> "Patient pathway and patient flow are important ad well". (Expert 1)
>
> "You would look at the ergonomics, the inflation of the cost and everything in it." (Expert 2)

Experts said that patients' involvement would help in achieving a better pathway, hence a successful HCF as Expert 1 said:

> "The question are asked of clinicians if we start with a blank piece of paper, what would the patient pathway look like?"

Expert 2 gave an example of his own experience about the patient pathway:

> "If you are involved in the built environment, you have to take some considerations, like, there is a machine you get to be put in one end and have to go about 10 different stations to get results."
>
> "I had an experience an inspection on my knee, they sent the X-ray next door and I had results in 5 min for me that's a revolution that more like clinic rather than hospital, I think this saves money."

He also added:

> "I like to encourage designers to have that discourse with the users". (Expert 2)

For the Post-Design Evaluation, Expert 1 added few requirements that should be completed by designers before evaluation:

> "HC organisations have to compete about their patients, you have to make an offer and you assume you get the patients for example; the birth unit of the RVI is absolutely a beautiful place so women are choosing where to go to."
>
> "So I think the built environment is a factor to have a bad facility and a good facility."

Expert 1 also added:

> "There is a funny phrase said by Willy 'look and feel' what is it look like what is it feel like to be in the building".

Finally, both experts added, "These are interestig things to know and to follow in the design" (Expert 1 and 2).

The matrices have been refined after the validation phase by taking into consideration all the feedback developed during the meeting (see Figure 6.5 and Figure 6.6).

Designers Req / FM evaluation	Schedule of accommodatio	Recovery rate of patient	Area schedules	Adjacency matrix	Material choice	Material lifespan	Fire&management policy	Transports	Patients' Measures	Ground conditions	Project procurement	Recovery rate of patient	Climate emergency	Sustainability	Resilience	Business continuity	Energy	Location/access	Demographics	Value engineering	Value management	Types of contracts	Flexibility of design	future proofing
Availability	X			X	X				X		X			X	X				X		X	X		X
Unavailability		X	X				X			X		X	X				X			X			X	

Figure 6.5: Matrix of Pre-Design Requirements (after validation).

HC users Req / Designers' evaluation	Privacy	Sound insulation	Sightline	Room layout same handed	Room layout inboard	Staff rooms	Changing rooms	Outdoor spaces	Rehab & therapy area	Quiet rooms	Play areas	Kitchens	Waiting rooms	Showers and restrooms	Dayrooms	Daylight	Artificial lights	Shading	Look and feel	Patient pathway	Ergonomics	Patient flow	Competition for use
Achieved	X			X	X		X			X		X	X	X	X			X	X			X	X
Unfinished		X	X					X			X					X	X			X	X		
Failed		X	X					X			X							X				X	X

Figure 6.6: Matrix of Post-Design Evaluation (after validation).

6.6 SUMMARY

This chapter has summarised the findings of the study, and discussed the areas of alignment and non-alignment between designers and HC users. The findings helped in developing the conceptual framework and matrices to be used for future research works for the design of healthcare facilities. The conceptual framework was developed based upon the findings of the surveys and interviews. The findings of the research helped in developing two matrices related to the design of healthcare facilities that should be used as pre-design and post-design requirements. The chapter also discussed the process of validation of the framework with the panel of experts. The framework and matrices developed have been discussed and refined after validation with the panel of experts. The next chapter will summarise the key findings of the research thesis and limitations, suggesting recommendations for further research works.

CHAPTER SEVEN

7 CONCLUSION

7.0 INTRODUCTION

This chapter concludes the main findings of the research and sheds lights on the contributions to knowledge. It also outlines the limitations of this research and further research works to develop in the future.

7.1 ACHIEVEMENT OF THE RESEARCH OBJECTIVES

The aim of the study was to develop a conceptual framework for the design of healthcare facilities based on users' needs. The rationale for this study arose from the fact that the design of healthcare facilities does not meet users' expectations. A comparison of the designers' performance with the healthcare users' satisfaction revealed some performance gaps in the design of healthcare premises. To address these a conceptual framework was developed and in order to achieve it, the following objectives were formulated:

1. Investigate the design issues and problem areas associated with the design of healthcare facilities.
2. From a sample of specialist healthcare design practices, determine:
    a. designers' awareness of the identified design issues and problem areas;
    b. the sources of knowledge that designers access (e.g. tacit or explicit)
    c. whether they use a systematic knowledge repository and/or digital technologies;
    d. the potential for operational feedback to inform better designs.
3. From a sample of experienced healthcare users, determine their satisfaction with the design of healthcare facilities.
4. From a comparison of the findings (2 and 3, above) identify key areas where there is a lack of alignment between designers' awareness and users' expectations.
5. From these key areas could be addressed and what steps would inform better designs.
6. Create a conceptual framework that enables the better capture and use of post-occupancy evaluation in healthcare facility design.

7. Explore the theoretical and practical implications of the findings and the framework, and their contribution to knowledge.
8. Make recommendations for further work including the implementation of the conceptual framework.

In order to achieve these objectives, this research used an exploratory sequential mixed method design to attain the research objectives from which the main findings were discovered.

The first objective of the study was to investigate the design issues and problem areas associated with the design of healthcare facilities, which was achieved through a literature review of the healthcare facilities' design. A series of issues were highlighted in the literature review, which represented a means to accomplish the second objective. This was addressed by first carrying out an in-depth research to select healthcare design practices. Then a survey was conducted with healthcare design specialists to clarify their awareness of the identified design issues and problem areas along with the sources of knowledge they access. A series of follow-up interviews with these specialists discussed the possibility of using a systematic knowledge repository and/or digital technologies as well as the clarification of potential operational feedback to inform better designs. The third objective was addressed by undertaking a survey with healthcare users that shed light on their opinions on the design of healthcare facilities. From the data collection, a comparison of these two sets of findings helped in achieving the fourth objective by highlighting the areas of nonalignment between designers' awareness and users' expectations. As a result, two matrices were developed to identify the designers' needs and users' requirements that would inform better designs. This addressed the fifth objective. The sixth objective was achieved by developing a conceptual framework that enables the better capture and use of post-occupancy evaluations in healthcare facility design. The seventh objective - to explain the theoretical and practical implications of the findings and their contribution to knowledge was addressed in the section below, as is the eighth objective, namely, to make recommendations for future research work including the implementation of these in practice.

7.2 CONTRIBUTION TO KNOWLEDGE

In the process of this investigation, a number of theoretical and practical contributions to knowledge emerged.

7.2.1 THEORETICAL PERSPECTIVES

Through its mixed method data collection strategy, the study explored designers' awareness of the key challenges and problem areas that exist in the design of healthcare facilities. In general, their awareness accorded with the literature on these issues. The study also compared designers' evaluation of their performance with the satisfaction of healthcare users. There were many instances where users were satisfied, though this was not the case in certain areas. In general, it appeared that designers were somewhat complacent about their performance, the methods they use, particularly the adequacy of their experience and tacit knowledge. In some cases, they could benefit from more systematic and explicit knowledge based upon post-occupancy feedback. Finally, the research contributes to existing taxonomies of design matters and design guidance that relates to healthcare facilities.

7.2.2 PRACTICAL PERSPECTIVES

The knowledge gained through this study contributed in the development of a conceptual framework that could be implemented on a live project in order to improve design capabilities and design decision making. In addition, it raises a level of awareness of designers regarding the users' needs and their satisfaction. This research contributed in the development of designers' requirements and healthcare users' needs in matrix format in terms of designing healthcare facilities in the UK. The matrices developed could be implemented as a Pre-Design Requirements and Post-Design Evaluation for any healthcare project in the design of inpatient ward.

7.3 CHALLENGES AND LIMITATIONS OF THE RESEARCH

The researcher encountered some challenges and limitations during the undertaking of the research. These are summarised as follows:

Collecting data from specialist designers: The design of healthcare facilities is a specialism offered by only a few architectural practices, and a considerable amount of sorting and selection was necessary to identify potential respondents and interviewees. In view of this, the number of respondents and interviewees was considered to be reasonable.

Collecting data from healthcare professionals: Conducting any study in the realm of healthcare presents specific challenges in terms of ethical approvals. Although no patients or other vulnerable individuals were included in the study, it was nevertheless subject to very strict and time-consuming ethical application procedures. Again, in view of this the number of respondents and interviewees was considered to be reasonable.

Input from other stakeholder groups: It was a delimitation of this study that patients' views were not included, given the ethical constraints described earlier. Further studies may usefully incorporate their views. Although the opinions of facilities managers are an important aspect of post-occupancy evaluation, that aspect was avoided in this study. The current study was deliberately limited to accessing the opinions of healthcare professionals. Further work could incorporate opinions of facilities managers.

7.4 RECOMMENDATIONS FOR FURTHER RESEARCH

The empirical research in this study was conducted entirely in the UK. Other countries have different procedures and possible different levels of expectation and these findings would not, therefore be directly applicable. Nevertheless, the data collection methods could apply. Healthcare facilities 'HCFs' include more than inpatients wards. However, this research focused on inpatient wards only. The occupancy of these wards is much greater than adult wards but the study focused on adults only. The possible respondents are greater than the actual respondents; however, the study selected only designers, clinicians and nurses. Similar approaches could be taken with other respondents beyond those that were considered in this study such as FM, patients and visitors within other spaces in HCFs that could include clinical areas, outpatient or others.

Evidence-based design is critical in the design of healthcare facilities (Alfonsi et al. 2014), as it can reduce: the spread of infection in hospitals, stress and injuries on medical staff, and improve the healing of patients. To maximise the impact of evidence-based design and thus improve user-satisfaction, there is a need to capture lessons learnt from occupied projects. Such evaluations could be stored in a database or a knowledge base using digital (BIM-type) technologies. The conceptual framework presented in this study could form a basis for a knowledge-based repository that would inform new designs. The conceptualised framework would represent a basis for its live implementation in the future by incorporating the emerging technologies, such as BIM. Further works could also include developing enablers of real-time and rapid feedback (for example, electronic touch screen tablets) that are accessible by healthcare users to notify facility managers 'FM' with the problem area (that were identified in the designers' survey) in the ward and/or the patient room. The notification of the problem area would allow FM to fix the problem and send the lessons learnt to designers. The research can be extended to other countries based upon their design guidance and regulations.

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APPENDICES

APPENDIX 1- SURVEY OF DESIGNERS

Survey: post occupancy feedback from designers

post occupancy evaluation

1)

Dear Sir/Madam,

As a well-known designer of healthcare facilities, I am hoping you can help by completing this short questionnaire survey. Its purpose is for information towards my PhD research titled "Knowledge Management in a digital age: the use of performance information for evidence-based design of the buildings" at the University of Northumbria.The aim of the research is to propose a knowledge management platform for design decision-making by using the information and capabilities of Building Information Modelling (BIM) in order to improve the current capabilities of Post Occupancy Evaluation "POE" and its impact on design decisions. The research focuses on health care buildings and the evaluation of their design. Your assistance in completing this questionnaire would be gratefully appreciated and your responses will be anonymous, treated confidentially, and used solely for research purposes. Please start with the survey now by indicating that you agree to participate (box below) and then clicking on the Continue button. Thank You!

☐ I confirm that my participation in this study is voluntary and understand that all results will be anonymous, treated confidentially, and used solely for research purposes.

1) what is the most critical area in the design of hospital wards?

In terms of issues that are most significant in designing a patient' room, please rank the following from the least important issue to the most important.

	The least important 10	20	30	40	50	60	70	80	90	The most important 100
* To avoid hospital acquired infections	-									
* To avoid medication errors (e.g. through w ard by increasing the number of private rooms to reduce errors)	-									
* To avoid falls (e.g. floor surfaces and lack of handrails)	-									
* Scalability, adpatability and flexibility of the space	-									
* Visual and acoustic privacy	-									

post occupancy feedback from designers

QuestionPro

* Isolation of rooms and beds	-
* Light and shade	-
* Colour used in the space	-
* Daylight and artificial light	-
* Air quality	-
* Noise	-
* Furniture placement	-

Please add further coments/ or issues.

* 2) Which issue (s) you get most user feedback on?

Others

* 3) Which issue (s) do you find hardest to address, and why?

Others

* 4) Which issue (s) you feel most comfortable in dealing with?

Others

* 5) Are there any other user acceptance issues that you face during the design of the patient's room?

Others

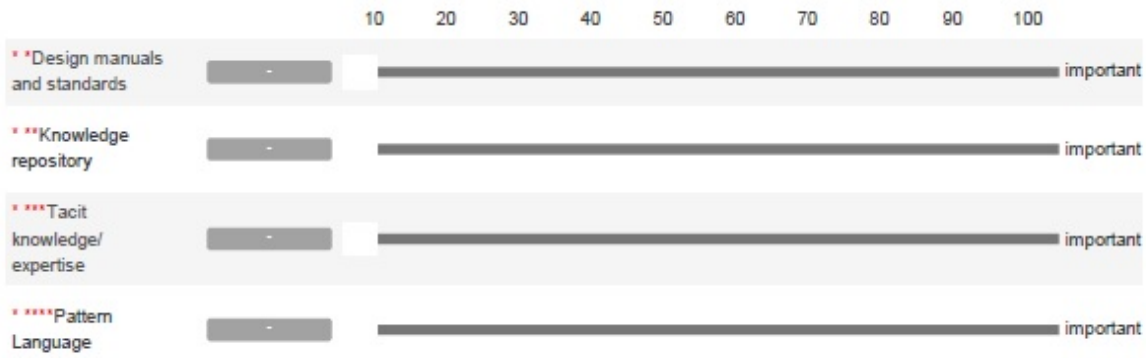
* Design manuals and standards: (e.g. Health Building Note 00-01, hospital and health care :construction and design manual book, websites (e.g. http://www.wbdg.org/building-types/health-care-facilities/hospital).

** Knowledge repository: a library of evidence-based design EBD references, that provides references provides information required to achieve the best possible outcomes for patients, residents, families, and staff through use of the evidence-based design process.

*** tacit knowledge/ expertise: Designer's experiences and tacit learning.

****Pattern Language is an architectural language, and a method of describing good design practices or patterns of useful organization within a field of expertise. . This language is used for improving neighbourhood, designing a house, workshop or public buildings like schools, it is also used as a guidance for the construction process (Alexander et al. 1977).

6) To what extent do you use the following in designing a hospital ward?



* 7) The above questions are about general hospital wards, In terms of adults in-patient wards, what are the main criteria of designing them and the main differences between them (such as burn centre, cardiology, intensive care, etc.)?

* 8) What data currently supports your day-to-day tasks for the design of hospital wards?

* 9) What further data would ideally improve/enhance your day-to-day task for the design of a hospital ward?

* 10) If your company uses BIM, Does your use of BIM depend upon?

- ☐ a- size of projects
- ☐ b- type of client
- ☐ c-type of project or client (e.g. because it is required by the client or the lead contractor)

post occupancy feedback from designers

Others

Would you like to take part in a short follow-up interview? if yes, please send an email to touria.bouazza@northumbria.ac.uk or fill in your details in the contact information and I will contact you.

Contact Information

First Name :

Last Name :

Phone :

Email Address :

APPENDIX 2- INTERVIEWS OF DESIGNERS

Designers' interview

Intro

My PhD research is about the exploration of knowledge management and its potential in the design of healthcare projects through a POE approach. This will be done by capturing tacit knowledge, turn it out into explicit and store it in a knowledge repository in BIM functions. The aim of this interview is to collect information about the design of healthcare projects, their feedback and the data that has to be captured, which you as a designer see as valuable data.

A. General- importance

1. Do you think user-feedback is important in the process of designing hospital wards? If yes, is it from the medical and nursing staff mainly, from patients and visitors or facility managers?

B. What feedback? How? When? Priority?

1. What is the most important criterion to refer to in the design of patient areas and especially in-patients wards?

2. Which category among them is the most important for you to get feedback from and why?

3. At what stage in the design process, do you use feedback from healthcare users and facility managers? In other words, when do you start using users-feedback while designing (during concept design/developed design or technical design?

4. How do you capture their feedback to use it in your design? How do you reuse it again?

5. What kind of data or information do you get in the design of hospital ward that should be useful from FM and HC users?

C. **What does not work?**

1. What don't you get that could be useful? Or the kind of additional data that could be useful information to you but are unexploited and, why do you think they are unexploited?
2. How could you use this data better?
3. Which data would inform better design? Exploited or unexploited? and how much of it? According to which criteria do you agree to this?
4. Are there any barriers/ or challenges to getting or reusing those feedback?

D. **What is the process of using feedback?**

1. How do you use this data transferred to you from facility managers and users? store it? Retrieve it? and reuse it?

E. **What is explicit, tacit, pattern language?**

1. Are you familiar with the terms tacit knowledge, explicit knowledge and pattern language?
2. Where does your tacit knowledge come from?

F. **Could tacit knowledge be explicit (e.g. knowledge repository)?**

1. What kind of tacit knowledge could be useful and therefore captured?
2. Regarding BIM where do you see yourself among these categories:
   i. Not aware of BIM and you don't use it
   ii. Aware of BIM and don't use it
   iii. Aware and use
3. Do you use BIM in your day-to-day task?
4. What are the aspects of design information (knowledge) that could be stored in BIM, in a way that you as a designer would think of using it in future design?

5. What aspects of BIM do you use?
6. To what extent do you use BIM technologies to inform your new design decision when designing a hospital ward? e.g. the use of BIM libraries and objects with parametric information ?
7. When you design with BIM, do you think transfer of data from users and facility managers is doable automatically?
8. What aspect you want the feedback transferred to you from users and facility managers in a way it could be stored in BIM?
9. Which data is most helpful to you geometric or non-geometric?

Could get

1. Does communal space represent one of the important keys in designing wards? What criteria do you follow in designing it?
2. Which ward amongst all (e.g. surgical ward, E.R, cardiology ward, ICU, neurology ward, oncology ward, etc.) you think should take the biggest attention in the design of hospitals and why? OR (which ward amongst all wards you think faces bigger challenges in the design layout than the others, and would need more feedback to be captured from users than other wards)?
3. How do you include space for patients' relatives in the design of single wards? And what about multi-bedrooms?
4. From the answers I got in the survey, it is quite important to keep the privacy of patients but at the same time they have to be observed, so what's your reaction to that and how do you cope with that issue? Where do you think this should be captured to be reused again?
5. Regarding the earlier survey, is there any other issues about designing hospital wards you would think of?

APPENDIX 3- SURVEY OF HEALTHCARE USERS (HOSPITAL)

Healthcare survey

How to improve the design of hospital wards through post-occupancy evaluation?

Hello,

My name is Touria and I am a research student at Northumbria University. I am working on a piece of research that is looking at how hospital wards and patient treatments spaces can be improved. I would like to invite you to take part in a survey to help me complete my project.

The survey will take around 10 to 12 minutes to complete. Your participation in this study is voluntary and you will not be required to enter any personal details. If you feel uncomfortable answering any questions, you can withdraw from the survey at any point.

Your survey responses will be confidential and the answers you provide will be pooled with others to form a reasonably large dataset. If you have questions about the survey or my research, please contact me at: touria.bouazza@northumbria.ac.uk

Thank you for your time and support.

To start the survey, please, can you tick the box below to confirm your agreement to participate. Thank You!

☐ I Agree

In this research, the term "patient areas" is used to describe areas such as wards and dayrooms, i.e., rooms where patients spend a significant amount of time. The terms does not include clinical areas.

• 1) What is your role in the hospital?

- ◯ A nurse
- ◯ A doctor or medical associate
- ◯ An allied health professional, i.e., occupational therapist, physiotherapist, etc.
- ◯ A midwife
- ◯ Other

• 2) How long have you been working in the healthcare sector?

- ◯ 0 - 4 years
- ◯ 5 - 9 years
- ◯ 10 - 15 years
- ◯ 15 years +

• 3) How long have you been working in a hospital?

- ◯ 0 - 4 years
- ◯ 5 - 9 years
- ◯ 10 - 15 years
- ◯ 15 years +

• 4) When working in a hospital environment, do you prefer working in:

- ◯ a- Single-patient rooms
- ◯ b- An open ward (e.g. multi bed rooms)

• Please explain why?

5) Please respond to the following questions using your reflections of your experience of working in patient areas that you are most familiar with? (Please add an explanation if you wish in the optional box) (1= poor; 2= fair; 3= good; 4= very good; 5= excellent).

* 5-1) How well are the patient areas in your hospital orientated towards daylight?

1 poor	2	3	4	5 excellent
☐	☐	☐	☐	☐

Optional comment

* 5-2) How good is the shading in the room to minimize the adverse affects of direct sunlight and solar exposure to patients?

1 poor	2	3	4	5 excellent
☐	☐	☐	☐	☐

Optional comment

* 5-3) How good are the artificial lights in the room?

1 poor	2	3	4	5 excellent
☐	☐	☐	☐	☐

Optional comment

6) Please indicate your agreement for the following statements (where: SD= Strongly Disagree; D=Disagree; N= Neutral; A= Agree; SA= Strongly Agree).

* A) The design of patient areas is very important to the patient's recovery and wellbeing.

SD	D	N	A	SA
☐	☐	☐	☐	☐

* B) A small communal ward, e.g., 4 to 6 bedrooms, provides a better recovery environment than a single patient bedroom.

SD	D	N	A	SA
☐	☐	☐	☐	☐

* C) Patients have enough privacy in patient areas.

SD	D	N	A	SA
☐	☐	☐	☐	☐

* D) The size of doors and doorways are important to accommodate all patients' needs.

SD	D	N	A	SA
☐	☐	☐	☐	☐

* E) Windows are large enough to allow patients to have a pleasing view.

SD	D	N	A	SA
☐	☐	☐	☐	☐

• F) The sound insulation is sufficient.

SD	D	N	A	SA
☐	☐	☐	☐	☐

• G) The room air temperature is appropriate in the patients' areas.

SD	D	N	A	SA
☐	☐	☐	☐	☐

• H) The patient areas are of adequate size.

SD	D	N	A	SA
☐	☐	☐	☐	☐

• I) The quality of the clinical furniture in the rooms, e.g., bins, chairs, lockers, etc., affects the well-being and recovery of patients.

SD	D	N	A	SA
☐	☐	☐	☐	☐

• J) The placement of clinical furniture is well suited to the recovery of patients and effective staff working.

SD	D	N	A	SA
☐	☐	☐	☐	☐

• K) The washing facilities are well suited to the recovery of patients and staff working.

SD	D	N	A	SA
☐	☐	☐	☐	☐

• L) Electric points are well suited to the recovery of patients and staff working.

SD	D	N	A	SA
☐	☐	☐	☐	☐

• M) Window blinds are well suited to the recovery of patients and staff work.

SD	D	N	A	SA
☐	☐	☐	☐	☐

• N) Equipment storage rooms are well suited to the recovery of patients and staff working.

SD	D	N	A	SA
☐	☐	☐	☐	☐

• O) The sightline from the doctors' and nurses' stations to the patients is adequate.

SD	D	N	A	SA
☐	☐	☐	☐	☐

• P) The visibility from the corridor to the patient rooms helps with patients' recovery.

SD	D	N	A	SA
☐	☐	☐	☐	☐

• Q) The patients' dignity and privacy are maintained.

SD	D	N	A	SA
☐	☐	☐	☐	☐

• R) The size of showers is sufficient to support the patients' recovery.

SD	D	N	A	SA
☐	☐	☐	☐	☐

• S) Bathroom's size is big enough for patient's recovery.

SD	D	N	A	SA
☐	☐	☐	☐	☐

• T) The patients' bedroom size is sufficiently large to support recovery.

SD	D	N	A	SA
☐	☐	☐	☐	☐

• U) Visitors have enough space to visit patients in their room.

SD	D	N	A	SA
☐	☐	☐	☐	☐

• V) Communal space is well equipped and designed for patients' recovery.

SD	D	N	A	SA
☐	☐	☐	☐	☐

• W) The circulation areas are conducive to the recovery of patients.

SD	D	N	A	SA
☐	☐	☐	☐	☐

* 7) Do you have enough spaces for lunchrooms, meeting rooms, rest areas, or relaxing rooms?

* 8) What other spaces do you think are important for you and patients?

* 9) What other spaces do you think are important to support patients?

IMPORTANT DEFINITIONS FOR THE NEXT QUESTION

Same-handed/mirrored room means the headwall is back-to-back in every pair of rooms and that all rooms are identical, staff will know exactly where everything is located no matter which room they are in or what unit they are on.

Inboard toilet room means placing the toilet room at the room entry and next to the corridor as in a typical hotel room. This approach provides the most space in the family zone, allows the best views of the outdoors and the most access to daylight, and offers the most privacy and acoustic separation from corridor noise.

Outboard toilet room means the toilet room is located along the exterior wall. The main advantage of this design is that it provides maximum patient visibility from the corridor.

Nested toilet room means two toilet rooms are located between every two patient rooms, resulting in one inboard and one outboard toilet room. This layout resolves the issues of patient visibility, privacy, adequate family space, and views to the outside, but makes the building longer which in turn adds to staff travel distances and may keep the building from fitting on its site.

10) Which room layout would be beneficial or helps you more in your day to day task? (see definitons above)

- [ ] a-Same handed rooms or mirrored rooms
- [ ] b-Inboard toilet rooms
- [ ] c-Outboard toilet rooms
- [ ] d-Nested toilet rooms
- [ ] PLease specify why

APPENDIX 4- SURVEY OF HEALTHCARE USERS (ACADEMIA/THIRD SECTOR)

Healthcare survey

Page 1

Hello,

My name is Touria and I am a research student at Northumbria University. I am working on a piece of research that is looking at how hospital wards and patient treatments spaces can be improved. I would like to invite you to take part in a survey to help me complete my project.

The survey will take around 10 to 12 minutes to complete. Your participation in this study is voluntary and you will not be required to enter any personal details. If you feel uncomfortable answering any questions, you can withdraw from the survey at any point.

Your survey responses will be confidential and the answers you provide will be pooled with others to form a reasonably large dataset. If you have questions about the survey or my research, please contact me at: touria.bouazza@northumbria.ac.uk

Thank you for your time and support.

To start the survey, please, can you tick the box below to confirm your agreement to participate. Thank You!

I consent to participate in the survey

- ○ Yes

Page 2

In this research, the term "patient areas" is used to describe areas such as wards and dayrooms, i.e., rooms where patients spend a significant amount of time. The terms does not include clinical areas.

1) What's your role in the hospital? * *Required*

- ○ A nurse
- ○ A doctor or medical associate
- ○ An allied health professional, i.e., occupational therapist, physiotherapist, etc.
- ○ A midwife
- ○ Other

If you selected Other, please specify:

2) How long have you been working in the healthcare sector? * *Required*

- ○ 0-4 Years
- ○ 5-9 Years
- ○ 10-15 Years
- ○ 15 Years+

3) How long did you work in a hospital? * *Required*

- ○ 0-4 Years

- ○ 5-9 Years
- ○ 10-15 Years
- ○ 15 Years+

4) When working in a hospital environment, did you prefer working in: ✱ *Required*

- ○ a- Single-patient ward
- ○ b- An open ward (e.g. multi-bed bay)

Please explain why?

5) Please respond to the following questions using your reflections of your experience of working in patient areas that you are most familiar with? (Please add an explanation if you wish in the optional box) (1= poor; 2= fair; 3= good; 4= very good; 5= excellent).

5-1) How well were the patient areas in hospitals orientated towards daylight? ✱ *Required*

Please don't select more than 1 answer(s) per row.

Please select exactly 1 answer(s).

	1	2	3	4	5	
Poor	☐	☐	☐	☐	☐	Excellent

Optional Comment

5-2) How good was the shading in the room to minimize the adverse affects of direct sunlight and solar exposure to patients? * *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	1	2	3	4	5	
Poor	☐	☐	☐	☐	☐	Excellent

Optional Comment

5-3) How good were the artificial lights in the room? * *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	1	2	3	4	5	
Poor	☐	☐	☐	☐	☐	Excellent

Optional Comment

6) Please indicate your agreement for the following statements (where: SD= Strongly Disagree; D=Disagree; N= Neutral; A= Agree; SA= Strongly Agree).

A) The design of patient areas is very important to the patient's recovery and wellbeing. * *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	SD	D	N	A	SA	
Strongly Disagree	☐	☐	☐	☐	☐	Strongly Agree

B) A small communal ward, e.g., 4 to 6 bedrooms, provides a better recovery environment than a single patient bedroom. ✱ *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	SD	D	N	A	SA	
Stronlgy Disagree	☐	☐	☐	☐	☐	Stronlgy Agree

C) Patients have enough privacy in patient areas.

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	SD	D	N	A	SA	
Stronlgy Disagree	☐	☐	☐	☐	☐	Stronlgy Agree

D) The size of doors and doorways are important to accommodate all patients' needs.

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	SD	D	N	A	SA	
Stronlgy Disagree	☐	☐	☐	☐	☐	Stronlgy Agree

E) Windows are large enough to allow patients to have a pleasing view.

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	SD	D	N	A	SA	
Stronlgy Disagree	☐	☐	☐	☐	☐	Stronlgy Agree

F) The sound insulation is sufficient.

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	SD	D	N	A	SA	
Stronlgy Disagree	☐	☐	☐	☐	☐	Stronlgy Agree

G) The room air temperature is appropriate in the patients' areas.

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	SD	D	N	A	SA	
Stronlgy Disagree	☐	☐	☐	☐	☐	Stronlgy Agree

H) The patient areas are of adequate size.

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	SD	D	N	A	SA	

Stronlgy Disagree	☐	☐	☐	☐	☐	Stronlgy Agree

I) The quality of the clinical furniture in the rooms, e.g., bins, chairs, lockers, etc., affects the well-being and recovery of patients.

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	SD	D	N	A	SA	
Stronlgy Disagree	☐	☐	☐	☐	☐	Stronlgy Agree

J) The placement of clinical furniture is well suited to the recovery of patients and effective staff working.

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	SD	D	N	A	SA	
Stronlgy Disagree	☐	☐	☐	☐	☐	Stronlgy Agree

K) The washing facilities are well suited to the recovery of patients and staff working.

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	SD	D	N	A	SA	
Stronlgy Disagree	☐	☐	☐	☐	☐	Stronlgy Agree

L) Electric points are well suited to the recovery of patients and staff working.

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	SD	D	N	A	SA	
Stronlgy Disagree	☐	☐	☐	☐	☐	Stronlgy Agree

M) Window blinds are well suited to the recovery of patients and staff work.

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	SD	D	N	A	SA	
Stronlgy Disagree	☐	☐	☐	☐	☐	Stronlgy Agree

N) Equipment storage rooms are well suited to the recovery of patients and staff working.

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	SD	D	N	A	SA	
Stronlgy Disagree	☐	☐	☐	☐	☐	Stronlgy Agree

O) The sightline from the doctors' and nurses' stations to the patients is adequate.

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	SD	D	N	A	SA	

Stronlgy Disagree	☐	☐	☐	☐	☐	Stronlgy Agree

P) The visibility from the corridor to the patient rooms helps with patients' recovery.

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	SD	D	N	A	SA	
Stronlgy Disagree	☐	☐	☐	☐	☐	Stronlgy Agree

Q) The patients' dignity and privacy are maintained.

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	SD	D	N	A	SA	
Stronlgy Disagree	☐	☐	☐	☐	☐	Stronlgy Agree

R) The size of showers is sufficient to support the patients' recovery.

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	SD	D	N	A	SA	
Stronlgy Disagree	☐	☐	☐	☐	☐	Stronlgy Agree

S) Bathroom's size is big enough for patient's recovery.

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	SD	D	N	A	SA	
Stronlgy Disagree	☐	☐	☐	☐	☐	Stronlgy Agree

T) The patients' bedroom size is sufficiently large to support recovery.

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	SD	D	N	A	SA	
Stronlgy Disagree	☐	☐	☐	☐	☐	Stronlgy Agree

U) Visitors have enough space to visit patients in their room.

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	SD	D	N	A	SA	
Stronlgy Disagree	☐	☐	☐	☐	☐	Stronlgy Agree

V) Communal space is well equipped and designed for patients' recovery.

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	SD	D	N	A	SA	

Stronlgy Disagree	☐	☐	☐	☐	☐	Stronlgy Agree

W) The circulation areas are conducive to the recovery of patients.

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	SD	D	N	A	SA	
Stronlgy Disagree	☐	☐	☐	☐	☐	Stronlgy Agree

7) Do you have enough spaces for lunchrooms, meeting rooms, rest areas, or relaxing rooms? ✱ *Required*

8) What other spaces do you think are important for you and patients? ✱ *Required*

9) What other spaces do you think are important to support patients? ✱ *Required*

IMPORTANT DEFINITIONS FOR THE NEXT QUESTION

Same-handed/mirrored room means the headwall is back-to-back in every pair of rooms and that all rooms are identical, staff will know exactly where everything is located no matter which room they are in or what unit they are on.

Inboard toilet room means placing the toilet room at the room entry and next to the corridor as in a typical hotel room. This approach provides the most space in the family zone, allows the best views of the outdoors and the most access to daylight, and offers the most privacy and acoustic separation from corridor noise.

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Nested toilet room means two toilet rooms are located between every two patient rooms, resulting in one inboard and one outboard toilet room. This layout resolves the issues of patient visibility, privacy, adequate family space, and views to the outside, but makes the building longer which in turn adds to staff travel distances and may keep the building from fitting on its site.

10) Which room layout would be beneficial or helps you more in your day to day task? (see definitons above) ✱ *Required*

Please select at least 1 answer(s).

- ☐ a-Same handed rooms or mirrored rooms
- ☐ b-Inboard toilet rooms

- [ ] c-Outboard toilet rooms
- [ ] d-Nested toilet rooms

Please specify why